Tierra Solutions, Inc.

Quality Assurance Project Plan for Newark Bay Study Area: Multi-beam and Single-beam Bathymetric Survey

December 2012

Revision 1

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Acronyms and Abbreviations

AOC	Administrative Order on Consent
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CPG	Cooperating Parties Group
CSM	conceptual site model
DQO	data quality objectives
EM	Engineer Manual
FSP	Field Sampling Plan
Ft	feet/foot
GPS	Global Positioning System
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
LPRRP	Lower Passaic River Restoration Project
N/A	not applicable
NBSA	Newark Bay Study Area
NGVD29	National Geodetic Vertical Datum of 1929
OSI	Ocean Surveys, Inc.
PM	Project Manager
PQO	project quality objectives
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RIWP	Remedial Investigation Work Plan
RPM	Remedial Project Manager
RTK	Real Time Kinematic
SOP	Standard Operating Procedure
SSO	Site Safety Officer
TBD	to be determined
Tierra	Tierra Solutions, Inc.
UFP	Uniform Federal Policy
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency

Section 1.

Introduction

1. Introduction

This Quality Assurance Project Plan (QAPP) has been prepared at the request of the U.S. Environmental Protection Agency (USEPA) to conduct a bathymetric survey of the Newark Bay Study Area (NBSA). Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Tierra Solutions, Inc. (Tierra), on behalf of Occidental Chemical Corporation (the successor to Diamond Shamrock Chemicals Company [formerly known as Diamond Alkali Company]), is required to collect data to support modeling activities associated with the NBSA pursuant to the Administrative Order on Consent (AOC) for Remedial Investigation and Feasibility Study, USEPA Index No. CERCLA 02-2004-2010 (USEPA 2004). USEPA requested that this survey be conducted consistent with the QAPP for the Lower Passaic River Restoration Project (LPRRP): Periodic Bathymetric Surveys (AECOM 2010) and subsequent Field Modification Form (AECOM 2011), and that this USEPA-approved LPRRP QAPP be used as a template for the NBSA survey. This QAPP details the proposed performance of a bathymetric survey within the NBSA and mouth of the Passaic River to support the numerical modeling being conducted by the Cooperating Parties Group (CPG) pursuant to the Administrative Settlement Agreement and Order on Consent for Remedial Investigation/ Feasibility Study (CERCLA 02-2007-2009) (USEPA 2007). The secondary objective for the survey is to characterize changes in bathymetry due to ongoing dredging in the study area resulting, in part, from the Harbor Deepening Project, which is deepening the navigation channels to -50 feet (ft) Mean Lower Low Water. The changes in bathymetry that have occurred since the last survey of the NBSA, which was conducted in 2005, will impact hydrodynamics and sediment transport in the system and the new survey data will support the conceptual site model (CSM) to reflect these changes in bathymetry.

This plan describes the implementation of the field data collection, data analysis, and associated quality assurance (QA) and quality control (QC) activities developed for this program.

This document uses applicable worksheets from the Uniform Federal Policy (UFP) on QAPPs [Publication Numbers: EPA: EPA-505-B-04-900A Department of Defense: DTIC ADA 427785] (USEPA 2005) and activity-specific Standard Operating Procedures (SOPs) for the field activities.

This is the second bathymetric survey conducted by Tierra for the NBSA. The first bathymetric survey conducted in 2005 was part of the Phase I Remedial Investigation Work Plan (RIWP; Tierra 2005) and used single-beam survey equipment. The coverage area included most of the NBSA, but there were areas that were not surveyed because of the upcoming deepening work (Tierra 2007). Additionally, single-beam surveys, as a function of the limits of the technology, do not generate full coverage of the survey area (in this case, the NBSA in 2005). The upcoming multi-beam and single-beam survey is planned to provide full bottom coverage within the entire NBSA and beyond. The targeted areas for the survey include the NBSA and mouth of the Passaic River. The survey will provide complete bottom coverage using multi-beam swath-type coverage for the majority of the survey area to -6 ft National Geodetic Vertical Datum of 1929 (NGVD29) (noting that this may present a challenge in some areas and require a field modification). As

water depths less than 6 ft are approached, it is anticipated that the multi-beam head will be tilted to cast the soundings out at an angle, rather than vertically, in select areas. This tilted (side-looking) method is anticipated to be utilized to extend the survey area, possibly into water depths less than 6 ft, captured by the multi-beam technology. Use of the tilted multi-beam methodology, however, requires USEPA approval following completion of a field-verification performance test based on criteria specified by USEPA (see Worksheet #11), pursuant to the U.S. Army Corps of Engineers (USACE) Hydrographic Surveying Manual (USACE 2002). For areas shallower than approximately 6 ft water depth that could not be reached by the multi-beam technology, single-beam technology will be used to extend the bathymetric data to approximately 2 ft water depth. To maximize coverage in shallow water, surveying will be conducted during times of high water (+/- 2.5 hours on either side of high tide).

1.1 Background Information

As part of the AOC (USEPA 2004) for the NBSA, remedial investigations have been underway in Newark Bay (the Bay) since 2004 to assess the nature and extent of chemical contamination associated with a legacy of chemical releases in the region. The Bay, part of the New York/New Jersey Harbor Estuary, is located between the shores of Newark and Elizabeth to the west, Jersey City and Bayonne to the east, the confluence of the Passaic and Hackensack Rivers to the north, and Staten Island to the south. Newark Bay is connected to Upper New York Bay by the Kill van Kull, and to Raritan Bay by the Arthur Kill. For purposes of this QAPP, the NBSA is bound by:

- The LPRRP downstream boundary
- The abandoned Conrail Bridge at the Hackensack River
- The Bayonne Bridge
- The Goethals Bridge

As part of the Phase I RIWP, a bathymetry survey was conducted using single-beam transects to accurately represent the depth and morphology of the Bay relative to known horizontal and vertical datums. This survey was conducted to define geomorphic areas and to assist field crews with sediment core collection. The survey lines for this survey were placed at placed at approximately 0.25-mile intervals and oriented perpendicular to the Bay, with more closely spaced, shorter survey lines around shoreline structures, bridge crossings, and sharp breaks in the navigation channel banks. Additional tie-lines were run, as appropriate, to obtain quality control data (Tierra 2005 and 2007).

Section 2.

QAPP Worksheets

QAPP Worksheet #1 (UFP-QAPP Manual Section 2.1) Title and Approval Page

Document Title: Quality Assurance Project Plan for Newark Bay Study Area: Multi-beam and Single-beam Bathymetric Survey

Lead Organization: Tierra

Preparer's Name and Organizational Affiliation: Carlie Thompson (Tierra)

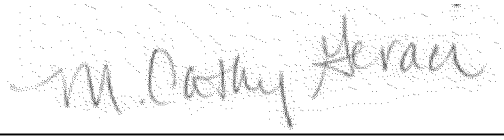
Preparer's Address, Telephone Number, and E-mail Address:

Tierra Solutions, Inc.
2 Tower Center Boulevard, 10th Floor
East Brunswick, New Jersey 08816

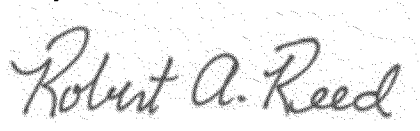
Phone: 732.246.5849
E-mail: Carlie.Thompson@tierra-inc.com

Preparation Date (Month/Day/Year): 12/03/2012

Investigative Organization's Project Manager



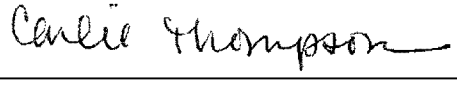
Cathy Geraci/ ARCADIS



Investigative Organization's Project QA Manager

Rob Reed/ ARCADIS

Lead Organization's Project Coordinator



Carlie Thompson/ Tierra

QAPP Worksheet #2 (UFP-QAPP Manual Section 2.2.4) QAPP Identifying Information

Site Name/Project Name:	NBSA/Multi-beam and Single-beam Bathymetric Survey
Site Location:	Newark Bay, New Jersey
Site Number/Code:	CERCLA Document No. 02-2004-2010
Operable Unit:	004
Contractor Name:	ARCADIS
Contractor Number:	Not Applicable (N/A)
Contract Title:	N/A
Work Assignment Number:	N/A

1. Identify guidance used to prepare QAPP:

   - USEPA. 2005. U.S. Department of Defense, and U.S. Department of Energy. Intergovernmental Data Quality Task Force. Uniform Federal Policy for Quality Assurance Project Plans. Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs. Part 1: UFP-QAPP Manual. USEPA 505-B-04-900A.Final Version 1. March.
   - USACE. 2002. Engineering and Design – Hydrographic Surveying. EM 1110-2-1003 Modified April 2004.

2. Identify regulatory program: CERCLA.

3. Identify approval entity: USEPA Region 2

4. Indicate whether the QAPP is a generic or a project-specific QAPP. (circle one)

5. List dates of scoping sessions that were held:

   - 20 September 2012 email exchange between Tierra, USEPA, and ARCADIS

6. List dates and titles of QAPP and Field Sampling Plan (FSP) documents written for previous site work, if applicable:

Title
Tierra. 2005. Newark Bay Study Area Remedial Investigation Work Plan. Sediment Sampling and Source Identification Program, Newark Bay, New Jersey. Phase I. Revision 1. Volumes 1-3. September.
Tierra. 2007. Newark Bay Study Area Remedial Investigation Work Plan. Sediment Sampling and Source Identification Program, Newark Bay, New Jersey. Phase II. Revision 2, Amendment 1. November.

7. List organizational partners (stakeholders) and connection with lead organization:

   This work will be performed under the requirements of the Administrative Order on Consent (CERCLA-02-2004-2010) (USEPA 2004) for the NBSA, with oversight conducted by USEPA and its government partners. Tierra (acting as Project Coordinator), has engaged ARCADIS and OSI to conduct the work on its behalf.

8. List data users: See item #7 above.

9. If any required QAPP elements and required information are not applicable to the project, then circle the omitted QAPP elements and required information on the attached table. Provide an explanation for their exclusion below:

   The planned bathymetric survey described in this QAPP involves the collection of field-measured electronic data only (vessel position, water depth below vessel, water [tide] level, and properties of the water mass [temperature and conductivity]). As such, a number of worksheets are not considered applicable to this investigation and are not included in this document.

   No laboratory analyses are required as part of this investigation, and therefore, the following worksheets are not applicable to this effort:

   #15 Data Quality Levels and Analytical Method Evaluation

   #19 Analytical SOP Requirements Table

   #23 Analytical SOP References Table

   #24 Analytical Instrument Calibration Table

   #25 Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

   #30 Analytical Services Table

   #36 Validation (Steps IIa and IIb) Summary Table

No physical samples will be collected as part of this investigation, and therefore, the following worksheets are not applicable to this effort:

#20 Field Quality Control Sample Summary Table

#26 Sample Handling System

#28 QC Samples Tables

Required QAPP Element(s) and Corresponding QAPP Section(s)	Required Information Relevant to Collection of Bathymetric Data	Crosswalk to QAPP Worksheet No. or Related Documents
Project Management and Objectives		
2.1 Title and Approval Page	- Title and Approval Page	1
2.2 Document Format and Table of Contents 2.2.1 Document Control Format 2.2.2 Document Control Numbering System 2.2.3 Table of Contents 2.2.4 QAPP Identifying Information	- Table of Contents - QAPP Identifying Information	 2
2.3 Distribution List and Project Personnel Sign-Off Sheet 2.3.1 Distribution List 2.3.2 Project Personnel Sign-Off Sheet	- Distribution List - Project Personnel Sign-Off Sheet	3 4
2.4 Project Organization 2.4.1 Project Organizational Chart 2.4.2 Communication Pathways 2.4.3 Personnel Responsibilities and Qualifications 2.4.4 Special Training Requirements and Certification	- Project Organizational Chart - Communication Pathways - Personnel Responsibilities and Qualifications Table - Special Personnel Training Requirements Table	5/Figure 1 6 7 8
2.5 Project Planning/Problem Definition 2.5.1 Project Planning (Scoping) 2.5.2 Problem Definition, Site History, and Background	- Project Planning Session Documentation (including Data Needs tables) - Project Scoping Session Participants Sheet - Problem Definition, Site History, and Background - Site Maps	9 9 10 Appendix A
2.6 Project Quality Objectives (PQOs) and Measurement Performance Criteria 2.6.1 Development of PQOs Using the Systematic Planning Process 2.6.2 Measurement Performance Criteria	- Site-Specific PQOs - Measurement Performance Criteria Table	11 12
2.7 Secondary Data Evaluation	- Sources of Secondary Data and Information - Secondary Data Criteria and Limitations Table	13
2.8 Project Overview and Schedule 2.8.1 Project Overview 2.8.2 Project Schedule	- Summary of Project Tasks - Project Schedule/Timeline Table	14 15 N/A 16

Required QAPP Element(s) and Corresponding QAPP Section(s)	Required Information Relevant to Collection of Bathymetric Data	Crosswalk to QAPP Worksheet No. or Related Documents
Measurement/Data Acquisition		
3.1 Sampling Tasks 3.1.1 Sampling Process Design and Rationale 3.1.2 Sampling Procedures and Requirements	- Sampling Design and Rationale - Sample Location Map - Sampling Locations and Methods/SOP Requirements Table - Project Sampling SOP References Table - Field Equipment Calibration, Maintenance, Testing, and Inspection Table	17 Appendix A 18/Appendix B 19 and 20 N/A 21 22
3.2 Analytical Tasks 3.2.1 Analytical SOPs 3.2.2 Analytical Instrument Calibration Procedures 3.2.3 Analytical Instrument and Equipment Maintenance, Testing, and Inspection Procedures 3.2.4 Analytical Supply Inspection and Acceptance Procedures		23, 24, 25 N/A
3.3 Sample Collection Documentation, Handling, Tracking, and Custody Procedures	- Sample Custody Requirements	26 N/A 27
3.4 QC Samples 3.4.1 Sampling QC Samples 3.4.2 Analytical QC Samples		28 N/A
3.5 Data Management Tasks 3.5.1 Project Documentation and Records 3.5.2 Data Package Deliverables 3.5.3 Data Reporting Formats 3.5.4 Data Handling and Management 3.5.5 Data Tracking and Control	- Project Documents and Records Table - Data Management Procedures	 29 30 N/A Appendix B
Assessment/Oversight		
4.1 Assessments and Response Actions 4.1.1 Planned Assessments 4.1.2 Assessment Findings and Corrective Action Responses	- Planned Project Assessments Table - Assessment Findings and Corrective Action Responses	31 32
4.2 QA Management Reports	- QA Management Reports Table	33
4.3 Final Project Report	- To be completed following data collection	Not available

Required QAPP Element(s) and Corresponding QAPP Section(s)	Required Information Relevant to Collection of Bathymetric Data	Crosswalk to QAPP Worksheet No. or Related Documents
Data Review		
5.1 Overview 5.2 Data Review Steps 5.2.1 Step I: Verification 5.2.2 Step II: Validation 5.2.3 Step III: Usability Assessment	 - Verification (Step I) Process Table - Verification (Steps IIa and IIb) Process Table - Usability Assessment	 34 35 36 N/A 37
5.3 Streamlining Data Review 5.3.1 Data Review Steps To Be Streamlined 5.3.2 Criteria for Streamlining Data Review 5.3.3 Amounts and Types of Data Appropriate for Streamlining	- To be completed following data evaluation	Not available

QAPP Worksheet #3 (UFP-QAPP Manual Section 2.3.1) Distribution List

QAPP Recipients	Title	Organization	Telephone Number	E-mail Address	Document Control Number
Eugenia Naranjo	Remedial Project Manager (RPM)	USEPA Region 2	212.637.3467	Naranjo.Eugenia@epamail.epa.gov	N/A
Stephanie Vaughn	RPM	USEPA Region 2	212.637.3914	Vaughn.Stephanie@epa.gov	N/A
Jay Nickerson	Site Remediation Manager	New Jersey Department of Environmental Protection	609.633.1448	Jay.Nickerson@dep.state.nj.us	N/A
Tim Kubiak	Assistant Supervisor of Environmental Contaminants	U.S. Fish and Wildlife	609.646.9310 x 26	tim_kubiak@fws.gov	N/A
Bryce Wisemiller	Project Manager	USACE - NY District	917.790.8307	bryce.w.wisemiller@usace.army.mil	N/A
Reyhan Mehran	Coastal Resource Coordinator	NOAA	212.637.3257	reyhan.mehran@noaa.gov	N/A
Carlie Thompson	Project Coordinator	Tierra	732.246.5849	carlie.thompson@tierra-inc.com	N/A
Clifford Firstenberg	Project Director	Tierra	757.258.7720	Clifford.firstenberg@tierra-inc.com	N/A
Cathy Geraci	ARCADIS Project Manager (PM)	ARCADIS	315.671.9567	Catherine.geraci@arcadis-us.com	N/A
Joseph Osso, Jr.	Bathymetry/ Data Management Task Manager	ARCADIS	518.250.7342	joseph.osso@arcadis-us.com	N/A
TBD	Field Oversight/ Site Safety Officer (SSO)	ARCADIS			N/A
Rob Reed	Project QA Manager	ARCADIS	315.671.9457	rob.reed@arcadis-us.com	N/A
George Reynolds	Bathymetric Survey Manager	OSI	860.388.4631 x112	ggr@oceansurveys.com	N/A
Bob Wallace	Bathymetric Survey Field Task Lead	OSI	860.388.4631 x129 860.227.3099 (cell)	rmw@oceansurveys.com	N/A
Robert Law	CPG Project Coordinator	de maximis, inc.	908.735.9315	rlaw@demaximis.com	N/A
Other project team members and stakeholders					N/A

QAPP Worksheet #4 (UFP-QAPP Manual Section 2.3.2) Project Personnel Sign-Off Sheet

Organization: A completed sign-off sheet will be maintained in the files for each organization shown below. A blank form is provided on the following page.

Project Personnel	Title	Telephone Number	Signature*	Date QAPP Read
Carlie Thompson	Project Coordinator (Tierra)	732.246.5849		
Clifford Firstenberg	Project Director (Tierra)	757.258.7720		
Cathy Geraci	PM (ARCADIS)	315.671.9567		
Joseph Osso, Jr.	Bathymetry/Data Management Task Manager (ARCADIS)	518.250.7342		
TBD	Field Oversight/SSO (ARCADIS)			
Rob Reed	Project QA Manager (ARCADIS)	315.671.9457		
George Reynolds	Survey Manager (OSI)	860.388.4631 x112		
Bob Wallace	Survey Field Task Lead (OSI)	860.388.4631 x129 860.227.3099 (cell)		

*Signature indicates that personnel have read the applicable QAPP sections and will perform the tasks as described.

QAPP Worksheet #4 (UFP-QAPP Manual Section 2.3.2) Project Personnel Sign-Off Sheet

Organization:

Project Personnel	Title	Telephone Number	Signature*	Date QAPP Read

*Signature indicates that personnel have read the applicable QAPP sections and will perform the tasks as described.

QAPP Worksheet #5 (UFP-QAPP Manual Section 2.4.1) Project Organizational Chart
(See Figure 1)

QAPP Worksheet #6 (UFP-QAPP Manual Section 2.42) Communication Pathways

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (timing, pathways, etc.)
Field activities status and issues	OSI Survey Field Task Lead	Bob Wallace	860.388.4631x129 860.227.3099 (cell)	Communicate daily with ARCADIS Bathymetry/Data Management Task Manager via e-mail or phone.
	ARCADIS Bathymetry/Data Management Task Manager	Joseph Osso, Jr.	518.250.7342	Communicate daily, or as needed, with OSI and Project Coordinator directly, or via e-mail or phone. Deviations and/or proposed revisions will be documented and communicated in writing, with a copy sent to Project Coordinator.
	Project Coordinator	Carlie Thompson	732.246.5849	Communicate daily, or as needed, with USEPA regarding status updates and deviations and/or proposed revisions received from ARCADIS PM or ARCADIS Bathymetry/Data Management Task Manager. Any revisions to procedures will be submitted to USEPA in writing or via e-mail prior to implementation.
Field and data processing analysis	OSI Survey Manager OSI Survey Field Task Lead	George Reynolds Bob Wallace	860.388.4631x112 860.388.4631x129 860.227.3099 (cell)	Communicate daily, or as needed, with ARCADIS Bathymetry/Data Management Task Manager via e-mail or phone.
	ARCADIS Bathymetry/Data Management Task Manager	Joseph Osso, Jr.	518.250.7342	Communicate daily, or as needed, with ARCADIS PM via e-mail or phone.
Health and safety briefings and updates	ARCADIS SSO	TBD		Communicate daily, or as needed, with field personnel and boat operators directly, or via e-mail or phone.

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (timing, pathways, etc.)
Significant health and safety concerns or incidents	ARCADIS Bathymetry/Data Management Task Manager	Joseph Osso, Jr.	518.250.7342	Communicate immediately with Project Team and ARCADIS Project Health and Safety Manager in accordance with the Health and Safety Plan (HASP). If ARCADIS Bathymetry Task Manager is not available, ARCADIS SSO will be responsible for communicating these issues.
Survey vessel operations	OSI Survey Field Task Lead	Bob Wallace	860.388.4631x129 860.227.3099 (cell)	Communicate daily, or as needed, with ARCADIS Field Oversight and/or ARCADIS Bathymetry/Data Management Task Manager directly.
Audit findings (field and/or data processing)	ARCADIS Project QA Manager	Rob Reed	315.671.457	Communicate findings to ARCADIS Bathymetry/Data Management Task Manager; transmit final audit reports, including corrective actions, to ARCADIS PM.
Issues potentially affecting data quality objectives (DQOs)	ARCADIS Bathymetry/Data Management Task Manager	Joseph Osso, Jr.	518.250.7342	Communicate with ARCADIS PM and Project Coordinator, via e-mail or phone. Significant work plan modifications will be proposed to the Project Coordinator.
Project status and issues (internal)	ARCADIS PM	Cathy Geraci	315.671.567	Communicate with Project Coordinator daily, or as needed, via email or phone, and submit monthly progress reports.
Project status and issues (external)	Tierra Project Coordinator	Carlie Thompson	732.246.5849	Communicate with USEPA, ARCADIS, and OSI as needed via e-mail or phone.

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (timing, pathways, etc.)
Data management	OSI Survey Field Task Lead	Bob Wallace	860.388.4631x129 860.227.3099 (cell)	Communicate with the ARCADIS Bathymetry/Data Management Task Manager via email; transmit final processed and supporting data files.
	ARCADIS Bathymetry/Data Management Task Manager	Joseph Osso, Jr.	518.250.7342	Communicate with the OSI Survey Field Task Lead on data transfer.
	ARCADIS Project Document Control Manager	Lois Ryfun	315.671.9507	Communicate with the ARCADIS Bathymetry/Data Management Manager to appropriately manage reports and data generated as part of this task
Stop Work (technical non-compliance)	OSI Field Team Leader, ARCADIS field team, Project QA Manager, and PMs			Any person believing that stopping work is necessary shall first verbally notify their respective PM, who will, in turn, verbally notify the Project Coordinator and/or the Project QA Manager, if necessary. Given the potential significance of such communications, this should occur as quickly as possible.

QAPP Worksheet #7 (UFP-QAPP Manual Section 2.4.3) Personnel Responsibilities and Qualifications Table

Name	Title	Organizational Affiliation	Responsibilities	Education and Experience Qualifications[1]
Carlie Thompson	Project Coordinator	Tierra	Overall responsibility for the safe and proper execution of task. Be available to discuss and review technical and other issues that may arise during work. Periodically review and audit work to ensure that work plan, project QA/QC, health and safety including both boating and hazardous materials worker safety procedures are being followed. All deviations from approved project plans will be discussed with and approved by the Project Coordinator. Primary point of contact with the USEPA and its oversight contractor.	B.S. Chemical Engineering; 8 years experience
Clifford Firstenberg	Project Director	Tierra	Technical lead on development of the procedures and methodologies associated with the bathymetric survey. Be available to discuss with Project Coordinator and Project Team any technical issues and/or any changes to operations and methods.	B.A. Earth and Planetary Sciences M.S. Marine Environmental Sciences/Physical Oceanography; 30 years experience
Rob Reed	Project QA Manager	ARCADIS	Responsible for reviewing and approving QA procedures, ensuring that planned QA assessments (e.g., technical surveillance audits, data validation) are conducted according to the QAPP and reporting on the adequacy of the QA Program to the ARCADIS PM.	B.S. Industrial Distribution/Engineering Management; 24 years experience
Cathy Geraci	ARCADIS PM	ARCADIS	Overall responsibility for technical, financial, and scheduling concerns of the NBSA Program. Primary point of contact with Project Coordinator.	B.S. Civil Engineering; 28 years experience

Name	Title	Organizational Affiliation	Responsibilities	Education and Experience Qualifications[1]
Joseph Osso, Jr.	Bathymetry/Data Management Task Manager	ARCADIS	Responsible for the execution and completion of the bathymetry survey, including procurement of subcontractors, reviewing task deliverables, and serving as the focus for coordination of all field tasks and subcontractor report and data development. Also responsible for data quality verification. The Bathymetry/Data Management Task Manager will keep the ARCADIS PM apprised of the status of the survey as well as communicate any issues with schedule, budget, or achievement of the task objectives.	B.S. Geology/B.A. Chemistry M.S. Environmental Science and Engineering; 7 years experience
TBD	Project Health and Safety Manager	ARCADIS	Responsible for ensuring that the objectives of ARCADIS HASP are met, and for monitoring task activities for conformance to the HASP.	
George Reynolds	Bathymetric Survey Manager	OSI	Responsible for ensuring training and qualifications of the survey team performing the investigation and for reporting status and issues to ARCADIS.	Certified Hydrographer; 37 years experience
Bob Wallace	Bathymetric Survey Field Task Lead	OSI	Responsible for safe and accurate implementation of the field data collection and post-survey data processing and quality.	B.S. Fisheries and Marine Technology, Certified Hydrographer; 17 years experience
TBD	Field Oversight/SSO	ARCADIS	Responsible for review of survey activities and methodology to ensure QAPP has been followed.	

[1] Resumes of all individuals are available upon request.

QAPP Worksheet #8 (UFP-QAPP Manual Section 2.4.4) Special Personnel Training Requirements Table

Project Function	Specialized Training by Title or Description of Course	Training Provider	Training Date	Personnel/ Groups Receiving Training	Personnel Titles/ Organizational Affiliation	Location of Training Records/ Certificates
Bathymetry/ Data Management Task Manager	40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) and HAZWOPER 8-hour Refresher	ARCADIS	August 2005 Annual refresher December 2012	Joseph Osso, Jr.	Bathymetry/Data Management Task Manager/ ARCADIS	ARCADIS
Field Personnel	40-hour HAZWOPER and HAZWOPER 8-hour Refresher	Various	March 1995 Annual Refresher January 2012 Various	Bob Wallace Various OSI	OSI	ARCADIS
	Applicable Vessel Operators License	Various	Various	Various OSI		
Field Oversight/ SSO	40-hour HAZWOPER/ HAZWOPER 8-hour Refresher	ARCADIS	within 12 months	TBD	Field Oversight/ ARCADIS	ARCADIS

QAPP Worksheet #9 (UFP-QAPP Manual Section 2.5.1) Project Scoping Session Participants Sheet

Project Name: Multi-beam and Single-beam Bathymetric Survey **Projected Date(s) of Sampling:** Fall/Winter 2012 **Project Managers:** Carlie Thompson/Cathy Geraci	**Site Name :** NBSA **Site Location :** Newark Bay, New Jersey
Date of Session: Session occurred by emails exchanged between 20 September 2012 and 21 September 2012 **Scoping Session Purpose:** Development of scope for bathymetric survey of NBSA.	

Name	Affiliation	Phone #	E-mail Address	Project Role
Eugenia Naranjo	USEPA	212.637.3467	Naranjo.Eugenia@epamail.epa.gov	USEPA RPM
Carlie Thompson	Tierra	732.246.5849	carlie.thompson@tierra-inc.com	Project Coordinator
Cathy Geraci	ARCADIS	315.671.9567	catherine.geraci@arcadis-us.com	PM
Joseph Osso, Jr.	ARCADIS	518.250.7342	joseph.osso@arcadis-us.com	Bathymetry/Data Management Task Manager

Comments/Decisions: USEPA and Tierra agreed to perform a multi- and single-beam survey for the NBSA. The work was agreed to be performed based on the AECOM (2010) QAPP approved by USEPA for the LPRRP. ARCADIS was tasked with revising the AECOM (2010) QAPP to fulfill the requirements of the NBSA bathymetric survey.

QAPP Worksheet #10 (UFP-QAPP Manual Section 2.5.2) Problem Definition

The problem to be addressed by the project:

The bathymetric survey will be conducted to generate a current dataset to represent the NBSA sediment bed elevations. These data are necessary to support the numerical modeling of Newark Bay and the Lower Passaic River being conducted by the CPG. Multi-beam technology, which provides complete bottom coverage, will provide a more detailed characterization than possible with single-beam technology for waters deeper than approximately 6 ft. As these shallow water depths are approached, it is anticipated that the multi-beam head will be tilted to cast the soundings out at an angle, rather than vertically. This tilted (side-looking) method is anticipated to be utilized to extend the survey area, possibly into water depths less than 6 ft, captured by the multi-beam technology. Use of the tilted multi-beam methodology, however, requires USEPA approval following completion of a field-verification performance test based on criteria specified by USEPA, pursuant to the USACE Hydrographic Surveying Manual (USACE 2002). Areas outside of the multi-beam coverage area will be characterized using single-beam technology to the operational limit of the vessel and transducer, approximately 2 ft.

The survey is intended to cover the entire NBSA (as defined by the Phase I and Phase II RIWPs) in addition to covering the mouth of the Passaic River. The survey area beyond the NBSA boundary at the mouth of the Passaic River is being surveyed to obtain data that overlaps with the recent CPG Lower Passaic River bathymetric survey to provide information to align the two surveys.

QAPP Worksheet #11 (UFP-QAPP Manual Section 2.6.1) Project Quality Objectives/Systematic Planning Process Statements

DQOs are described in Section 3 of this QAPP and listed below:

PRIMARY STUDY QUESTIONS/NEEDS

A quantitative bathymetric dataset needs to be collected for use in numerical models of the system, which are currently in development.

PROGRAM GOALS

In addition to addressing the primary study question/need above, this program would provide empirical data for updating the CSM.

ALTERNATIVE ACTIONS

N/A

For the planning process associated with this task the following are addressed:

WHO WILL USE THE DATA?

USEPA and its Partner Agencies, Tierra, and the CPG.

WHAT WILL THE DATA BE USED FOR?

The data will be used by EPA and the CPG to support numerical modeling of Newark Bay and the Lower Passaic River, and by Tierra for upcoming investigations associated with the NBSA.

WHAT TYPE OF DATA IS NEEDED?

Sediment bed elevation data (referenced to a standard datum) and associated positioning coordinates.

HOW MUCH DATA ARE NEEDED?

The goal of this survey is to obtain as complete coverage of the NBSA and the mouth of the Passaic River, as possible by boat. The field conditions will determine exactly how much of the survey area can be safely navigated by the vessels.

The multi-beam survey of the NBSA and mouth of the Passaic River will involve transects to obtain complete coverage of the sediment surface. It is anticipated that the multi-beam technology will only be used for waters deeper than approximately 6 ft. Data may also be collected by multi-beam in shallower waters and near debris or structures by tilting the multi-beam head ("side-looking") in areas where the vessel cannot safely operate to extend the area of multi-beam coverage. The tilted multi-beam head method will only be utilized following field-verification of the method and agreement between USEPA (or USEPA's representative), OSI, Tierra, and ARCADIS.

Single-beam coverage for the bathymetry task will be conducted in areas that are too shallow to be reached by vessel or pose a risk to the multi-beam head due to shallow waters or debris. The transects for the single-beam survey will be spaced approximately 100 ft apart and are planned to overlap the multi-beam coverage area by 100 ft. The single-beam transects will be oriented nominally perpendicular to shore or the overwhelming contour trend in a given area. Areas such as the flats in the southwest corner of Newark Bay will be sounded on a line plan consisting of lines oriented at various azimuths. It is anticipated that this technology will be utilized in waters ranging from 2 to less than 6 ft in depth.

During the survey, the Real Time Kinematic (RTK) Global Positioning System (GPS) will record position and water surface elevation at a minimum of 10 Hertz.

Throughout the survey, the tide gage will record water surface elevation at 6-minute intervals for backup and comparison to the RTK GPS. Additionally, checks will be made against the tide staff at least once per day.

The conductivity-temperature-depth casts for water column sound speed profile determination will be done at a frequency, based on field observations, necessary to accurately describe the water column conditions. At a minimum, three conductivity-temperature-depth casts will be performed each day with additional casts as conditions require.

HOW GOOD DO THE DATA NEED TO BE?

The data must be technically sound, properly documented, and undergo the quality checks for consistency and meet or exceed all standards defined for multi-beam and single-beam bathymetric surveys in accordance with USACE (2002) guidelines. However, the modern equipment planned for utilization during this survey, as well as the methods in place to minimize error, are likely to exceed the minimum standards presented by the USACE (2002) guidelines.

In addition to all other QA/QC checks (bar check, SV cast, position verification, etc.), performance testing of the multi-beam system will be comprised of a "beam angle" test (multi-beam to multi-beam surface comparison) and "single-beam" test (single-beam soundings to multi-beam surface comparison). This test will be performed in a deep, flat, and unobstructed (no debris) area.

- The "beam angle" test will show a statistical comparison of multi-beam data accuracy at different angles.

- The "single-beam" test will show a statistical comparison of multi-beam data to the single-beam surroundings.

- The mean bias between the two datasets (either multi-beam to multi-beam or single-beam to multi-beam) should be less than 0.2 feet, and the maximum outlier between the two sets should be less than 1.0 foot.

The multi-beam equipment also has the ability to be tilted for a "side-looking" multi-beam survey to expand the area covered by the multi-beam technology. This method will be specifically tested for accuracy by performing a "single-beam" test and a "modified" multi-beam comparison test. This test will be performed in a shallow, sloped area.

- The multi-beam test will be considered "modified" because the reference surface will be collected with a vertical ("down-looking") multi-beam survey, but the check surface will be collected with a side-looking multi-beam (off to one side). A statistical comparison will be conducted between the side-looking multi-beam data to the already-measured, reference surface, down-looking multi-beam data previously described.

- A statistical comparison will be made between a performance surface created using side-looking multi-beam data to single-beam data. The HYPACK "Single Beam Test" utility will be used for comparison. The test area will be chosen based on field observations. In general, the test area will be shallow and sloping rather than deep and flat as recommended for the test described above.

- The mean bias between multi-beam to multi-beam and single-beam to multi-beam datasets should be less than 0.2 feet, and the maximum outlier between the two datasets should be less than 1.0 foot for this test.

As part of this survey, method-specific check lines will be performed. These method-specific check lines are single-beam data that would be "tied" with the single-beam system and multi-beam data that would be "tied" with the multi-beam system. The method-specific check lines are independent of the proposed 100-foot overlap between the multi-beam and single-beam survey data.

WHEN WILL THE DATA BE COLLECTED?

The data are planned to be collected during Fall and Winter 2012.

QAPP Worksheet #12 (UFP-QAPP Manual Section 2.6.2) Measurement Performance Criteria Table

Matrix	Water				
Analysis	N/A				
Concentration Level	Not available				
Sampling Procedure	**Analytical Method/SOP**	**Data Quality Indicators**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
Standard Surface Test	USACE Hydrographic Surveying Manual, EM 1110-2-1003 (USACE 2002)	Accuracy/Bias, Precision	Mean Bias < 0.2 ft; Maximum Outlier < 1.0 ft	Prior to surveying and at various times throughout survey	S
Modified Surface Test (for side-looking multi-beam)	USACE Hydrographic Surveying Manual, EM 1110-2-1003 (USACE 2002)	Accuracy/Bias, Precision	Mean Bias < 0.2 ft; Maximum Outlier < 1.0 ft	Prior to surveying to prove capabilities	S
Horizontal positioning accuracy	USACE Hydrographic Surveying Manual, EM 1110-2-1003 (USACE 2002)	Accuracy/Bias, Precision	Chapter 3, Table 3-1, Sections 3-8, 3-14 Chapter 5, Sections 5-2, 5-4 Chapter 16	Daily benchmark check	S
Elevation/depth accuracy		Accuracy/Bias, Precision	Chapter 3, Table 3-1, Section 3-7 Chapter 11, Table 11-2[1]	Bar check	S
Measurement of water surface elevation		Accuracy/Bias, Precision	Chapter 3, Table 3-1 Chapter 5, Sections 5-6 – 5-11	Consistency review	S
Measurement of water column properties to allow calculation of speed of sound		Accuracy/Bias, Precision	Chapter 3, Table 3-1, Sections 3-3, 3-14	Multiple measurements	S

[1] Exceptions/clarifications to the standards presented in Table 11-2 of the USACE (2002) manual include 1) a precise "bar check" will be used in lieu of the "plate check"; and 2) a 455 kHz multi-beam system is proposed for use.

QAPP Worksheet #13 (UFP-QAPP Manual Section 2.7) Secondary Data Criteria and Limitations Table

Secondary Data	Data Source (Originating Organization, Report Title, and Date)	Data Generator(s) (Originating Org., Data Types, Data Generation/ Collection Dates)	How Data Will Be Used	Limitations on Data Use
Full Surveys or Bathymetric Studies of NBSA Recently Performed by Others[1]				
Bathymetric survey	Sommerfield and Chant. Mechanisms of Sediment Trapping and Accumulation in Newark Bay, New Jersey: An Engineered Estuarine Basin. Hudson River Foundation Report. 2010.	Hudson River Foundation. Single-beam survey (Knudsen B/P 320 single-beam echosounder) performed by Sommerfield and Chant in the NBSA in 2008.	Characterize bathymetry, identify areas of long-term sediment accumulation in Newark Bay for comparison to the seasonal depositional pattern identified by previous coring studies.	Single-beam survey – accuracy was evaluated using the cross-line check method (described in the USACE Hydrographic Surveying Manual, EM 1110-2-1003 (USACE 2002)
Bathymetry Study and Model	USACE. Geomorphological/ Geophysical Characterization of the Nature and Dynamics of Sedimentation and Sediment Transport in Newark Bay focusing on the Effects related to Continued and Future Federal Navigation Channel Deepening and Maintenance. 2006.	A study conducted by USACE to produce a clear and accurate portrayal of sediment dynamics and geomorphology in Newark Bay and identify areas of high deposition that might persist in Newark Bay. Includes bathymetric data and historical information from numerous sources to develop models of the changing bathymetry in Newark Bay.	Developed in support of the Harbor Deepening Project as well as the Remedial Investigation/Feasibility Study for Newark Bay.	Comprises many bathymetric sources, both historical and recent. Also, the development of bathymetric models involved combining multiple sources.
Work Recently Performed by Tierra on NBSA				
Bathymetric surveys	Tierra. Phase II RIWP. 2007.	Tierra Single-beam surveys performed by OSI 2005.	Characterize existing bathymetry, compare with other survey data to assess sediment stability.	Single-beam survey – direct comparison at co-incident transects only.

[1] It is beyond the scope of this table and not efficient to evaluate surveys of limited spatial coverage of Newark Bay that may have been conducted in support of specific projects and data collected prior to 2000.

QAPP Worksheet #14 (UFP-QAPP Manual Section 2.8.1) Summary of Project Tasks

Field Surveying Task: A survey control point will be established and a recording tide gage and tide staff installed. The tide gage will be installed at the northeast corner of Port Elizabeth. This is the same location utilized during the 2005 NBSA Phase I survey. The approximate location of the proposed tide gage installation, expressed in NJ State Plan Coordinate System, NAD83, US Feet, is as follows: E 592,275 N 670,604. The control point, tide gage and tide staff will be installed in a manner consistent with the standard operating procedures presented in Appendix B.

A multi-beam bathymetric survey will be performed across the entire NBSA and extending into the mouth of the Passaic River. The multi-beam survey will be conducted in all waters safely accessible to the vessel and equipment, generally 6 ft NGVD. The proposed multi-beam equipment will obtain complete coverage of the sediment floor, limited by bridges and other in-water structures.

The choice to utilize the tilted multi-beam methodology, following USEPA's approval for use, will be determined based on field observations and based upon agreement with USEPA or USEPA's representative. Generally, the field team will assess a given area with the following:

- The aerial extent (width) and submerged river bank slope angle of the fringe area
- The amount of debris or obstructions in a fringe or inter-pier area
- The complexity of the local water column sound speed profile.

Any areas of the survey area that are unable to be surveyed by multi-beam technology will be surveyed by single-beam technology. The single-beam transects are planned at 100-ft separation, nominally perpendicular to the shore or overwhelming contour trend in a given area, or on a line plan with lines oriented at various azimuths. The single-beam survey will cover water depths from approximately 2 to 6 ft, and will overlap the multi-beam survey area by approximately 100 ft.

Prior to the start of survey work, field-verification performance testing will be conducted to verify the multi-beam methodologies to be utilized.

Analysis Tasks: Water depth data obtained using the multi-beam equipment will be processed using speed of sound in water data to correct for the effects of sound wave refraction in the water column. The single-beam echosounder will be calibrated for local water mass speed of sound by means of a bar check.

Water surface elevation data will be used to associate instantaneous water depths with a known vertical datum to accurately take into account the fluctuation of the water surface due to astronomical and meteorological forces during the survey.

Quality Control Tasks: QC tasks will be completed as specified in the USACE Hydrographic Surveying Manual, EM 1110-2-1003 (USACE 2002), and as summarized in Worksheet #22.

Secondary Data: All relevant secondary/historical data are summarized on Worksheet #13.

Data Management Tasks: The raw bathymetric data will be reviewed and processed by OSI following the procedures specified in the USACE Hydrographic Surveying Manual, EM 1110-2-1003, (USACE 2002). The handling of records and data is summarized on Worksheet #29.

Documentation and Records: Project-related records (e.g., field, raw data, and processed data) are summarized on Worksheet #29.

Assessment/Audit Tasks: Field audits will be scheduled in accordance with Worksheet #31.

Data Review Tasks: Field data will be reviewed as described in Worksheet #34.

Reporting Tasks: Deliverables are summarized in Worksheet #16 and include a summary report and submittal of raw and processed data files.

QAPP Worksheet #16 (UFP-QAPP Manual Section 2.8.2) Project Schedule/Timeline Table

Activities	Organization	Dates		Deliverable	Deliverable Due Date
		Anticipated Date(s) of Initiation	Anticipated Date of Completion		
Project Status	Tierra/ ARCADIS	Monthly	Monthly	Progress report	20th of each month
Planning and Development of Study Objectives	Tierra/ ARCADIS	Completed	Completed	QAPP	QAPP submitted November 9, 2012, revise as needed
Performance of Bathymetric Survey	ARCADIS/ OSI	December 2012	January 2013	Raw data files	Delivered along with the processed data
Processing of Survey Data	OSI	January 2013	March 2013	Processed data files, supporting files, and contoured maps	Approximately 60 days following completion of field survey (dependent on the amount of required processing)
Quality Review and Evaluation of Sample Data	Tierra/ ARCADIS	March 2013	April 2013	Included in Survey Summary Report	April 30, 2013
Preparation and Delivery of Survey Summary Report	Tierra/ ARCADIS	April 2013	May 2013	Survey Summary Report	May 31, 2013

Note: Specific date of initiation of the survey is dependent on equipment availability.

QAPP Worksheet #17 (UFP-QAPP Manual Section 3.1.1) Sampling Design and Rationale

Describe and provide a rationale for choosing the sampling approach (e.g., grid system, biased statistical approach): Multi-beam survey technology provides complete coverage of the bay or river bottom and enables generation of a more complete and accurate bathymetry than does single-beam technology. The multi-beam transects will be planned to optimize coverage with the multi-beam technology for complete bottom coverage of the survey areas. The multi-beam equipment, pending USEPA approval, will also be tilted in shallow areas and near obstructions/debris to maximize coverage with this survey technique.

In areas that are too shallow for the multi-beam technology to be safely utilized, single-beam technology will be used. The area that will be covered by single-beam technology will be between approximately 2 and 6 ft water depth. The survey lines for the single-beam survey will be spaced approximately 100 ft apart along the outer limits of the multi-beam coverage area and will extend from approximately 2 ft water depth to 100 ft into the multi-beam coverage area to ensure sufficient coverage and overlap.

Describe the sampling design and rationale in terms of what matrices will be sampled, what analytical groups will be analyzed and at what concentration levels, the sampling locations (including QC, critical, and background samples), the number of samples to be taken, and the sampling frequency (including seasonal considerations):

As no physical samples will be collected or analyzed, many of the items noted in this entry are not applicable.

The survey area includes full coverage of the NBSA with some coverage into the mouth of the Passaic. The proposed multi-beam survey will be performed to cover as much of the survey area as possible including as close as practicable to bridges and other in-water structures. A side-looking technique will be applied with the multi-beam technology that involves tilting the echosounder head to cast at an angle rather than vertically; this will expand the area covered by the multi-beam equipment. All multi-beam methods will only utilize data recorded from beams that are +/- 45 degrees from nadir, consistent with USACE (2002) guidance and the previous work conducted by the CPG (AECOM 2010, 2011).

The accuracy of the tilted multi-beam methodology will be evaluated in the field by acquiring a dataset using this method over a small area, then utilizing a single-beam survey over the same area to compare results between the two techniques. The results

of the comparison will be evaluated by USEPA (or USEPA's representative), OSI, Tierra, and ARCADIS to verify the accuracy of the method and, if in agreement, the tilted (side-looking) multi-beam methodology will be utilized for areas of the survey designated in Appendix A.

Areas that are unreachable by the multi-beam technology will be surveyed using a single-beam system at transects spaced 100 ft apart around the outer limits of the multi-beam coverage area and extending into shallower water. The single-beam transects will be oriented nominally perpendicular to the shore or the overwhelming contour trend in a given area, or a line plan consisting of lines oriented at various azimuths. The single-beam equipment will be utilized in water depths that are approximately 2 to 6 ft water depth and in areas where debris or other obstructions put the multi-beam equipment at risk for damage.

QAPP Worksheet #18 (UFP-QAPP Manual Section 3.1.1) Sampling Locations and Methods/SOP Requirements Table

Sampling Location/ Identification Number	Matrix	Depth (units)	Survey Type[1]	Concentration Level	Number of Samples[2]	Sampling SOP Reference	Rationale for Sampling Location
NBSA	Elevation (ft – NGVD29)	≥ 6 ft	Multi-beam	N/A	Full bottom coverage including data collection as close as practicable to bridges and other in-water structures; multi-beam swath will not exceed +/- 45 degrees from nadir.	USACE Hydro-graphic Surveying Manual, EM 1110-2-1003 (USACE 2002)	To provide quantitative data for a numerical model of the Newark Bay/Lower Passaic River system and empirical data for updating the CSM.
NBSA	Elevation (ft – NGVD29)	<6 ft; narrow/ steep riverbank fringe area	Tilted (side-looking) Multi-beam	N/A	Full bottom coverage of certain areas 6 ft or less using multi-beam technology with a tilted echosounder head (pending USEPA approval); multi-beam swath will not exceed +/- 45 degrees from nadir.	USACE Hydro-graphic Surveying Manual, EM 1110-2-1003 (USACE 2002)	To provide quantitative data for a numerical model of the Newark Bay/Lower Passaic River system and empirical data for updating the CSM.
NBSA	Elevation (ft – NGVD29)	>2 ft and < 6 ft	Single-beam	N/A	Transects spaced 100 ft apart along the furthest extent of the multi-beam survey area, including coverage from approximately 2 ft water depth to 100 ft into the multi-beam coverage area.	USACE Hydro-graphic Surveying Manual, EM 1110-2-1003 (USACE 2002)	To provide quantitative data for a numerical model of the Newark Bay/Lower Passaic River system and empirical data for updating the CSM.

Sampling Location/ Identification Number	Matrix	Depth (units)	Survey Type[1]	Concentration Level	Number of Samples[2]	Sampling SOP Reference	Rationale for Sampling Location
Mouth of the Passaic River	Elevation (ft – NGVD29)	≥ 6 ft	Multi-beam	N/A	Full bottom coverage including data collection as close as practicable to bridges and other in-water structures; multi-beam swath will not exceed +/- 45 degrees from nadir.	USACE Hydrographic Surveying Manual, EM 1110-2-1003 (USACE 2002)	To provide empirical data outside NBSA boundaries for additional data representation of the system. This will provide additional coverage and overlap with other datasets to support numerical modeling of the Newark Bay/Lower Passaic River system and update the CSM.
Mouth of the Passaic River	Elevation (ft – NGVD29)	<6 ft; narrow/ steep riverbank fringe area	Tilted (side-looking) Multi-beam	N/A	Full bottom coverage of certain areas 6 ft or less using multi-beam technology with a tilted echosounder head (pending USEPA approval); multi-beam swath will not exceed +/- 45 degrees from nadir.	USACE Hydrographic Surveying Manual, EM 1110-2-1003 (USACE 2002)	To provide empirical data outside NBSA boundaries for additional data representation of the system. This will provide additional coverage and overlap with other datasets to support numerical modeling of the Newark Bay/Lower Passaic River system and update the CSM.

Sampling Location/ Identification Number	Matrix	Depth (units)	Survey Type[1]	Concentration Level	Number of Samples[2]	Sampling SOP Reference	Rationale for Sampling Location
Mouth of the Passaic River	Elevation (ft – NGVD29)	>2 ft and < 6 ft	Single-beam	N/A	Transects spaced 100 ft apart along the furthest extent of the multi-beam survey; including coverage from approximately 2 ft water depth to 100 ft into the multi-beam coverage area.	USACE Hydrographic Surveying Manual EM 1110-2-1003 (USACE 2002)	To provide empirical data outside NBSA boundaries for additional data representation of the system. This will provide additional coverage and overlap with other datasets to support validation of a hydrodynamic model and update the CSM.

[1] The decision on survey methodology type will be based on field observations and based on agreement with USEPA or USEPA's representative.

[2] Full bottom coverage (either by multi- or single-beam methodologies) may not be realized regardless of depth in areas encumbered by moored vessels, debris, etc.

QAPP Worksheet #21 (UFP-QAPP Manual Section 3.1.2) Project Sampling SOP References Table

The following is a list of SOPs associated with project activities including, but not limited to, field data collection, equipment testing, inspection and maintenance, supply inspection and acceptance, and data analysis.

Reference Number	Title, Revision Date and/or Number	Originating Organization	Equipment Type	Modified for Project Work? (Y/N)	Comments
N/A	Field Documentation SOP No. 1; December 2012	ARCADIS	N/A	Yes	Appendix B
N/A	Data Management SOP No. 2; December 2012	ARCADIS	N/A	Yes	Appendix B
N/A	Tide Gage Installation SOP No. 3; December 2012	ARCADIS	Tide gage	Yes	Appendix B
N/A	Multi-beam Bathymetric Surveying SOP No. 4; December 2012	ARCADIS	Echosounder and positioning equipment	Yes	Appendix B
N/A	Single-beam Bathymetric Surveying SOP No. 5; December 2012	ARCADIS	Echosounder and positioning equipment	Yes	Appendix B
EM 1110-2-1003	USACE Hydrographic Surveying Manual (USACE 2002)	USACE	Bathymetric Survey System (depth measurement, vessel positioning)	No	A reference for this document can be found in Appendix B

Procedural modifications to these documents may be warranted depending upon field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification will be approved in advance by the ARCADIS Project QA Manager and ARCADIS PM and communicated to the Project Coordinator and to the USEPA RPM. Deviations will be documented in the field records.

QAPP Worksheet #22 (UFP-QAPP Manual Section 3.1.2.4) Field Equipment Calibration, Maintenance, Testing, and Inspection Table

Field Equipment[1]	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
Real Time Kinematic Global Positioning System	Verify and check all horizontal and vertical control and datum before beginning any survey	Per manufacturer's instructions	Accuracy of position	Alignment with known benchmark	Prior to survey and daily thereafter	Manufacturer's published accuracy	Resurvey for positional accuracy	Survey Field Task Lead or designee	USACE Hydrographic Surveying Manual, EM 1110-2-1003 (USACE 2002)

Field Equipment[1]	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
Echosounder	Perform proper bar check procedures both before and after daily survey operations and, for multi-beam system, any time the transducer is rotated from down-looking to the side-looking orientation	Per manufacturer's instructions	Confirm measured value aligns with known depth	Daily	Daily	Section 9-3 of the USACE Hydrographic Surveying Manual	Recalibrate or replace	Survey Field Task Lead or designee	USACE Hydrographic Surveying Manual, EM 1110-2-1003 (USACE 2002)

Field Equipment[1]	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
Echosounder	Conduct latency check of both the single-beam and multi-beam systems. Conduct patch test to determine multi-beam system angular offsets.	Per manufacturer's instructions	N/A	Determining latency of system	Daily	N/A	Remove latency from field data	Survey Field Task Lead or designee	USACE Hydrographic Surveying Manual, EM 1110-2-1003 (USACE 2002)
Echosounder	Field check for data integrity	Per manufacturer's instructions	N/A	Confirm that: (1) quality digital data (i.e., no spikes or false echo from prop wash) are being recorded and (2) soundings are being collected at a maximum of 5-ft intervals	Real time	No data spikes or false echo from prop wash are being recorded and soundings are being collected at a maximum of 5-ft intervals	Adjust data collection as required to remove deficiencies	Survey Field Task Lead or designee	USACE Hydrographic Surveying Manual, EM 1110-2-1003 (USACE 2002)

Field Equipment[1]	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
Tide gage	QC of RTK GPS-derived sea surface correction to field data	Per manufacturer's instructions	N/A	Tide data will be taken at 6-minute intervals, and tide data must exist for the entire survey period in order for the survey data to be correctly processed	Real time	Intact data stream. Tide gages installed at a surveyed elevation	Replace the tide gage if Acceptance Criteria are not met.	Survey Field Task Lead or designee	USACE Hydrographic Surveying Manual, EM 1110-2-1003 (USACE 2002)
Echosounder	N/A	N/A	QC check	For single-beam echosounder, annotate the paper chart with "event marks." Also include line number and date/time.	Mark 10-second intervals on survey lines	Retain ability to compare digital and scroll data, and as backup if digital data are lost/destroyed	N/A	Survey Field Task Lead or designee	USACE Hydrographic Surveying Manual, EM 1110-2-1003 (USACE 2002)
Multi-beam	N/A	N/A	N/A	Data acceptance	Data processing cue	All multi-beam data collection and post-processing procedures will meet or exceed standards presented in the USACE Hydrographic Surveying Manual, EM 1110-2-1003 (USACE 2002).	N/A	Survey Field Task Lead or designee	USACE Hydrographic Surveying Manual, EM 1110-2-1003 (USACE 2002)

Field Equipment[1]	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
Multi-beam	N/A	N/A	N/A	Multi-beam will provide complete coverage of the survey area. This practice prevents data gaps caused by mound or trench shadowing from occurring in the survey (where practical).	Real-time	Accepted overlap	Adjust vessel position and HYPACK line file spacings	Survey Field Task Lead or designee	USACE Hydrographic Surveying Manual, EM 1110-2-1003 (USACE 2002)

[1] A listing of equipment types can be found in Appendix A.

QAPP Worksheet #27 (UFP-QAPP Manual Section 3.3.3) Sample Custody Requirements

Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to laboratory): N/A

Laboratory Sample Custody Procedures (receipt of samples, archiving, disposal): N/A

Sample Identification Procedures: N/A

Chain-of-Custody Procedures: N/A

Chain of Custody Procedure: N/A

Transfer of Custody and Shipment: N/A

Sample Packaging and Shipping Requirements: N/A

Laboratory Custody Procedures: N/A

Final Evidence Files

All field data including raw data files, tide files, and navigation files will be provided to ARCADIS in accordance with the contractual agreement and will be retained by ARCADIS along with associated field records and other related correspondence. Final evidence files as retained by ARCADIS will include, but not be limited to, correspondence (paper and email), plans, contractual documents, maps and drawings, field data, calculations, assessment reports, and progress and data reports. This information will be maintained in a secure area according to the procedures outlined in the ARCADIS Data Management SOP.

QAPP Worksheet #29 (UFP-QAPP Manual Section 3.5.1) Project Documents and Records Table

Sample Collection Documents and Records	On-site Analysis Documents and Records	Off-site Analysis Documents and Records	Data Assessment Documents and Records	Other
N/A	Field notes, field data sheets, field logbooks	Data processing notes	Reports of field audits	Progress reports
	Field instrument calibration records	Communication logs	Data evaluation reports	Final report - Prepared and submitted to clients and USEPA
	Field measurement data		QA reports to management	
	QAPP and HASP		Correction action reports and results	
	Correction action reports and results			
	Documentation of field modifications and non-conformances			
	Daily Activity Log			

This section describes the project data management process for tracking the data from their generation through final use and/or storage. All project data, communications, and other information must be documented in a format useable to project personnel.

Project Document Control System

Project documents are controlled according to the Data Management SOP (Appendix B) which addresses maintaining and managing hardcopies and electronic copies of all project related documents. Electronic copies of all information relating to this project are maintained on the project network files which are backed up at least once per day; access to these files is limited to authorized project personnel. All project data and information must be documented in a standard format which is usable by all project personnel.

Data Recording

Almost all of the data generated during this investigation (position, depth, water level) will be captured electronically. Any manually recorded data will be entered by hand into bound field logbooks and later transferred to an electronic record.

Data Quality Assurance Procedures

ARCADIS will monitor the survey progress to verify that data are collected and recorded as planned. The survey contractor must maintain a QC Plan to which they adhere and which addresses all data-generating aspects of daily operations. A policy of continuous improvement will allow all data generation processes to be reviewed and modified, as needed, to meet project objectives. Audits of field operations will ensure that data collection, documentation, and QC procedures are being followed.

Laboratory Data Transmittal

N/A

Data Storage and Retrieval

Completed forms, logbooks, photographs, data packages, and electronic files will be transmitted to the ARCADIS Project Document Control Manager at the completion of the survey. Raw data and electronic files of all field data and QC analyses must be maintained by the survey contractor in accordance with the terms of their contract with Tierra. Project closeout will be conducted in accordance with contractual obligations. As required by the AOC (USEPA 2004) for the NBSA, all data and other project records will be made available to USEPA. Records will be retained in accordance with the AOC requirements.

The data transfer to USEPA will include the raw data files, processed data files, supporting data files (line, position), and interpolated bathymetric maps with 1.0-ft contour interval.

QAPP Worksheet #31 (UFP-QAPP Manual Section 4.1.1) Planned Project Assessments Table

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment	Person(s) Responsible for Responding to Assessment Findings	Person(s) Responsible for Identifying and Implementing Corrective Actions	Person(s) Responsible for Monitoring Effectiveness of Corrective Actions
Technical Oversight of Field Activities	Once during the first few days of field operations; follow-up audits as necessary	Internal	ARCADIS	ARCADIS Field Oversight or designee	Bathymetry/Data Management Task Manager/ ARCADIS PM	Bathymetry/Data Management Task Manager/ Field Oversight	ARCADIS PM

QAPP Worksheet #32 (UFP-QAPP Manual Section 4.1.2) Assessment Findings and Corrective Action Responses

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response	Timeframe for Response
Field System Audit	Written audit report	PM, Bathymetry/Data Management Task Manager/Field Oversight, OSI Survey Manager	Verbal summary of major findings within 24 hours; written report within 1 week.	Memo with possible re-audit	ARCADIS Project QA Manager, PM, Bathymetry/Data Management Task Manager	One week

Non-Conformance/QC Reporting

A non-conformance is defined as an identified or suspected deficiency in, or deviation from, procedures described in an approved document (e.g., improper surveying techniques, improper equipment setup or calibration, errors in calculations or errors in computer algorithms); an item where the quality of the end product itself or subsequent activities conducted using the document or item would be affected by the deficiency; or an activity that is not conducted in accordance with established plans or procedures. Any project staff member that discovers or suspects a non-conformance is responsible for initiating a non-conformance report to the Project QA Manager. The Project QA Manager will evaluate each non-conformance report and provide a response describing the actions to be taken and assigning responsibility for the corrective action. The appropriate Task Manager will verify that the nonconforming item or procedure is not used until the corrective action has been performed and found to produce acceptable results. If the non-conformance involves instrumentation or equipment, the device must be tagged to indicate it is defective and not to be used.

All non-conformance reports will be maintained in the project file.

Assessment

Assessment activities will measure the effectiveness of the project implementation and associated QA/QC activities. Audits are used as a means of monitoring the performance of field and data processing activities and are conducted by the Project QA Manager or another member of the QA staff. Audits will include systems audits

which are more qualitative in nature and will be made at appropriate intervals to ensure that all aspects of the QA program are operative. Performance audits are quantitative audits which are conducted to assess the accuracy of measurement systems.

Systems audits will be conducted for field and processing operations to assess implementation of QA/QC requirements and determine if the systems under review are capable of meeting project DQOs. Any minor deficiencies noted during an audit will be corrected as soon as possible according to an agreed-upon schedule. If a major deficiency is noted during an audit, a stop work order will be issued until the deficiency can be corrected and the effectiveness of the corrective action measured and documented. A stop work order may be issued by the ARCADIS Project QA Manager who will notify the ARCADIS PM. The conditions which lead to a stop work order must be documented in sufficient detail to clearly define the problem and identify possible corrective measures. All communications among project staff which address evaluation of the problem and appropriate solutions must be attached to the stop work order. The ARCADIS Project QA Manager and the PM must agree in writing to resume work after review of the data supporting correction of the deficiency. The Project QA Manager will maintain a corrective action log which lists deficiencies that were noted, the individual(s) responsible for follow-up, documentation of the effectiveness of the corrective actions taken, and implementation of procedures to prevent recurrence of the problem.

A written report will be prepared for all audits regardless of the outcome and submitted to the ARCADIS PM. Any modifications to the existing program, corrective actions required, or the need for additional audits will be documented.

QAPP Worksheet #33 (UFP-QAPP Manual Section 4.2) QA Management Reports Table

Type of Report	Frequency	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation	Report Recipient(s)
Progress Reports	Monthly	Due the 20th of each month	Project Coordinator	USEPA RPM
Audit Reports	During the first three days of survey and as needed for follow up	Within one week after field work begins and as required during program	ARCADIS Project QA Manager or designee	Bathymetry/Data Management Task Manager, OSI Survey Manager, ARCADIS PM
Nonconformance report	As needed	When a nonconformance is identified	ARCADIS staff	ARCADIS Project QA Manager, ARCADIS PM, ARCADIS Bathymetry/Data Management Task Manager, USEPA RPM
Corrective Action Reports	When corrective action is required	When corrective action is implemented	ARCADIS Project QA Manager or Bathymetry/Data Management Task Manager	ARCADIS PM, Bathymetry/Data Management Task Manager, and Project Team Members, USEPA RPM

The monthly progress report will address the results of any corrective actions or audits which took place during the reporting period. Problems or issues which arise between regular reporting periods may be identified to management at any time. Information included in the monthly progress report will include:

- Results of audits conducted during the reporting period;
- Discussion of problems with measurement data including issues related to precision, accuracy, completeness, representativeness, and comparability that could affect achievement of the DQOs; and
- A listing of any non-conformance reports or stop-work orders, the associated corrective actions taken, and the outcome of these corrective actions.

QAPP Worksheet #34 (UFP-QAPP Manual Section 5.2.1) Verification (Step I) Process Table

Verification Input	Description	Internal/ External	Responsible for Verification
Field data	Field data will be reviewed for completeness to ensure that data for vessel positioning, water depth and tidal measurements, and temperature and conductivity measurements are present for all transects or at the appropriate required intervals.	Internal	OSI Bathymetry Survey Manager or designee
Processed data	Processed data will be reviewed prior to release to ensure completeness or reported results.	Internal	OSI Bathymetry Survey Manager or designee
Assessment actions and reports	QA/QC process will be reviewed for agreement with QAPP to ensure that all necessary audits and assessments have been performed.	Internal	ARCADIS Project QA Manager Project Coordinator

QAPP Worksheet #35 (UFP-QAPP Manual Section 5.2.2) Validation (Steps IIa and IIb) Process Table

Step IIa/IIb	Validation Input	Description	Responsible for Validation
IIa	Field records, USACE Hydrographic Surveying Manual, EM 1110-2-1003 (USACE 2002)	Verify conformance to approved procedures and verify that deviations from procedures or criteria were documented	OSI Bathymetry Survey Manager
IIa	Field records, database output	Verify that transcription of field data from field forms to electronic files (if applicable) and processing of data was accurate and complete	OSI Bathymetry Survey Manager
IIa	Field records, audit reports, deliverables	Verify conformance to contractual specifications	ARCADIS Field Oversight/SSO or designee
IIa/b	Field observations, field records	Verify conformance to procedures and criteria specified in QAPP and assess impact of deviations	ARCADIS Field Oversight/SSO or designee
IIb	Field records, processed data	Review data and processing procedures to ensure conformance with the project quality requirements. This will include review of positioning controls, survey quality controls (latency, bar check), line files, tidal corrections, and speed-of-sound corrections	ARCADIS Field Oversight/SSO; Bathymetry/Data Management Task Manager
IIb	Assessments, audit reports	Verify that data evaluations and technical audits were performed per the QAPP	ARCADIS QA Manager

QAPP Worksheet #37 (UFP-QAPP Manual Section 5.2.3) Usability Assessment

Summarize the usability assessment process and all procedures, including interim steps and any statistics, equations, and computer algorithms that will be used:
OSI will review the data collected for spikes, biases, and interferences on a daily basis to confirm data usability for all portions of the Bay that are surveyed.

Describe the evaluative procedures used to assess overall measurement error associated with the project:
The overall measurement error will be evaluated in a manner consistent with the USACE (2002) guidance as described in Worksheets #34 and #35. The assessment of overall measurement error will be part of the post-data collection review conducted by OSI.

Identify the personnel responsible for performing the usability assessment:
The usability assessment will be performed jointly by the ARCADIS and OSI project teams and will include input by field personnel, QA staff, and project management.

Describe the documentation that will be generated during usability assessment and how usability assessment results will be presented so that they identify trends, relationships (correlations), and anomalies:
The documentation generated during the usability assessment will be developed jointly by ARCADIS and OSI and will include a comprehensive memorandum that describes the information that was reviewed and the results of this review; it will also include a recommendation on overall data usability and limitations on specific data points.

Section 3.

Data Quality Objectives

3. Data Quality Objectives

DQO Step	DQO 1: Develop a bathymetric dataset from multi-beam and single-beam survey technologies to support numerical model development of the NBSA and the Lower Passaic River. Description
STEP 1 **State the problem**	A numerical model of the Lower Passaic River/Newark Bay system is under development by the CPG. A fundamental input to the hydrodynamic/sediment transport model is the physical characteristics of the water basin (i.e., the bathymetry); a bathymetric survey is required to develop the required dataset of the system.
STEP 2 **Identify the goals of the study**	**Primary Study Questions/Needs** ▪ A quantitative bathymetric dataset needs to be collected for application to numerical models of the system, which are currently in development. **Program Goals** In addition to addressing the study question/need outlined above, this program would provide empirical data for updating the CSM. **Alternative Actions** ▪ N/A
STEP 3 **Identify the information inputs**	**New Data Needed** Bathymetric data throughout the NBSA of a quality that meets or exceeds the requirements of the USACE surveying manual (USACE 2002). **Existing Field Data to Be Compared with Data Collected during This Investigation** ▪ Primarily. 2005 single-beam survey conducted by OSI for Tierra as part of the Phase I RIWP (Tierra 2005). ▪ Secondarily. Datasets collected by other parties (i.e., Sommerfield and Chant [2010]).

DQO Step	DQO 1: Develop a bathymetric dataset from multi-beam and single-beam survey technologies to support numerical model development of the NBSA and the Lower Passaic River Description
STEP 4 **Define the boundaries of the study**	**Geographic Area** Newark Bay, part of the New York/New Jersey Harbor Estuary, is located between the shores of Newark and Elizabeth to the west, Jersey City and Bayonne to the east, the confluence of the Passaic and Hackensack Rivers to the north, and Staten Island to the south. Newark Bay is linked to Upper New York Bay by the Kill van Kull, and to Raritan Bay by the Arthur Kill. For purposes of this QAPP, the NBSA is bounded by the Lower Passaic River Restoration Project boundary and the abandoned Conrail bridge at the Hackensack River to the north, and the Bayonne and Goethals Bridge to the south. A bathymetric survey is proposed to cover the entire NBSA as defined by the NBSA boundaries, above, with the exception of the Passaic River, which will be surveyed to the abandoned Conrail bridge to provide overlap with the CPG's recent survey of the Lower Passaic River. The proposed multi-beam and single-beam survey will be performed as close as practicable to bridges and other in-water structures. **Time Frame** The survey is planned for late Fall/Winter 2012.
STEP 5 **Develop the analytical approach**	The purpose of this survey will be to generate a high resolution bathymetric dataset of the NBSA to support upcoming work with a representation of the existing conditions. The NBSA surveying will be performed in accordance with the USACE Hydrographic Surveying Manual, EM 1110-2-1003 (USACE 2002).

DQO Step	DQO 1: Develop a bathymetric dataset from multi-beam and single-beam survey technologies to support numerical model development of the NBSA and the Lower Passaic River Description
STEP 6 **Specify performance or acceptance criteria**	For bathymetric measurements, uncertainty is introduced from a number of sources including the accuracy of the depth measurement instrument, the accuracy of the vessel positioning instrument, the marrying of the position data with depth data, the accuracy of the water level recording instrumentation, and data processing techniques. The approach described in "A method for comparing bathymetric survey data to determine changes in sediment elevation" by J. Herzog and A.S. Bradshaw (2005) will be used to define the overall uncertainty associated with the inter-survey comparisons as part of the assessment of the data. The accuracy of a multi-beam surface measurement is approximately +/- 0.5 ft; therefore all comparisons of measurements between surveys will have total depth uncertainty of approximately +/- 1 ft. Thus, all differences of less than approximately 1 ft will be within the uncertainty band of the multi-beam survey comparison and cannot be considered a real difference in depth. Similarly, the single-beam survey will also have a total depth uncertainty of approximately +/- 1 ft. The minimum accuracy requirements are those presented in the USACE (2002) guidelines. However, the equipment planned for this survey, as well as the methodologies that have been established to minimize error, will likely exceed these minimum standards.
STEP 7 **Develop the detailed plan for obtaining data**	Following the guidance of the USACE Hydrographic Surveying Manual, EM 1110-2-1003 (USACE 2002), a multi-beam and single-beam survey will be performed over the NBSA consistent with the survey methods utilized in a recent survey of the Passaic River (AECOM 2010, 2011). Details of the plan are presented in the QAPP worksheets and supporting Appendices.

Section 4.

References

4. References

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AECOM. 2011. Field Modification Form FM-120830-1. Revision 2. June.

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Sommerfield, C.K. and R.J. Chant. 2010. Mechanisms of Sediment Trapping and Accumulation in Newark Bay, New Jersey: An Engineered Estuarine Basin. Hudson River Foundation Report HRF 008/07A. July.

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USACE. 2006. Geomorphological/Geophysical Characterization of the Nature and Dynamics of Sedimentation and Sediment Transport in Newark Bay focusing on the Effects related to Continued and Future Federal Navigation Channel Deepening and Maintenance. Contract #: W912DS-06-D-0001.

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USEPA. 2007. Administrative Settlement Agreement and Order on Consent for Remedial Investigation/Feasibility Study, Lower Passaic River Study Area, USEPA Index No. CERCLA-02-2007-2009.

Figure

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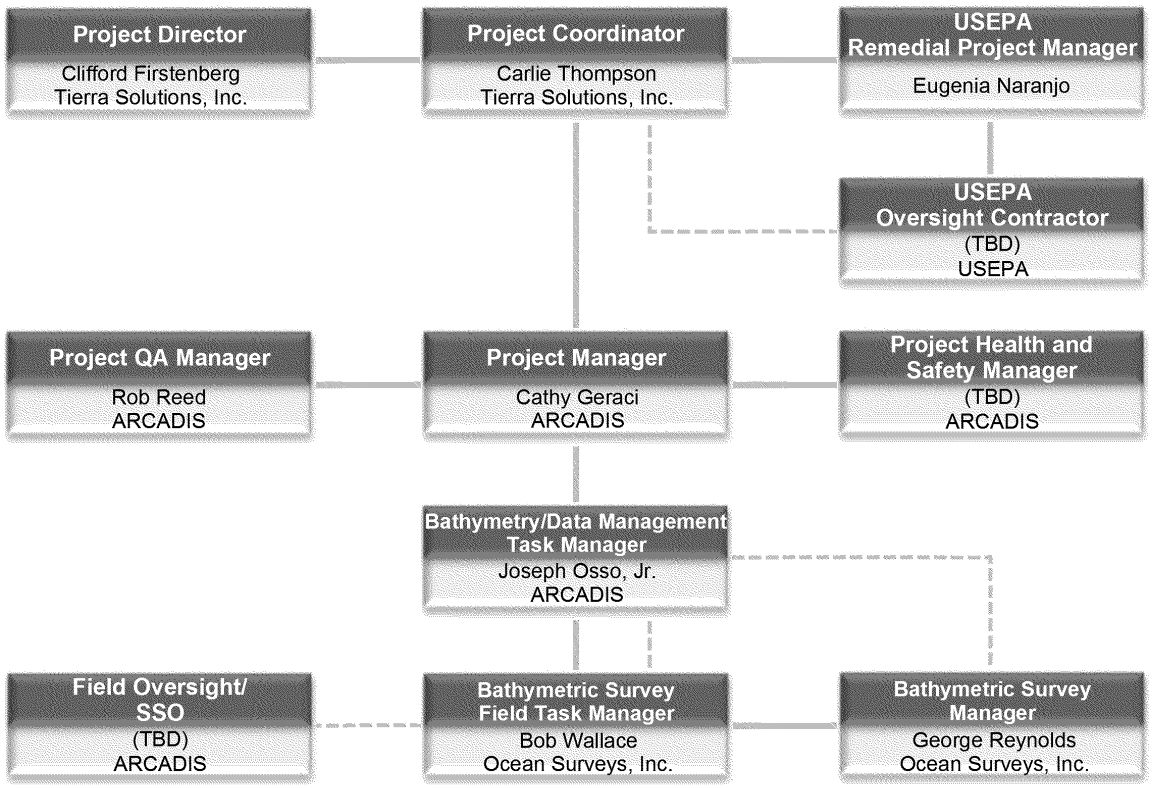

NEWARK BAY STUDY AREA REMEDIAL INVESTIGATION

QUALITY ASSURANCE PROJECT PLAN MULTI-BEAM AND SINGLE-BEAM BATHYMETRIC SURVEY

QAPP WORKSHEET #5
(UFP-QAPP MANUAL SECTION 2.4.1)
PROJECT ORGANIZATIONAL CHART

DECEMBER 2012

FIGURE
1

Appendix A

Field Sampling Plan

Field Sampling Plan

Multi-beam and Single-beam Bathymetric Survey

Newark Bay Study Area

Tierra Solutions, Inc.

East Brunswick, New Jersey

December 2012

Revision 1

Field Sampling Plan
Multi-beam and Single-beam
Bathymetric Survey

Cathy Geraci
Senior Project Manager, ARCADIS U.S., Inc.

Robert Reed
Quality Assurance Manager, ARCADIS U.S., Inc.

December 2012

Table of Contents

Acronyms and Abbreviations

AOC	Administrative Order on Consent
CPG	Cooperating Parties Group
CSM	Conceptual Site Model
FSP	Field Sampling Plan
ft	feet
GPS	Global Positioning System
HASP	Health and Safety Plan
NBSA	Newark Bay Study Area
NGVD29	National Geodetic Vertical Datum of 1929
QAPP	Quality Assurance Project Plan
RIWP	Remedial Investigation Work Plan
RTK	Real Time Kinematic
Tierra Solutions, Inc.	Tierra
USEPA	U.S. Environmental Protection Agency

Field Sampling Plan
Multi-beam and
Single-beam
Bathymetric Survey

December 2012

1. Introduction

This Field Sampling Plan (FSP) has been prepared at the request of the U.S. Environmental Protection Agency (USEPA), pursuant to the Administrative Order on Consent (AOC) Index No. CERCLA 02-2004-2010 (USEPA 2004) for Tierra Solutions, Inc. (Tierra), to conduct a bathymetric survey of the Newark Bay Study Area (NBSA) as part of the NBSA Remedial Investigation/Feasibility Study. USEPA further requested that the Quality Assurance Project Plan (QAPP) and FSP be prepared to be consistent with the AECOM (2010, 2011) QAPP for the Lower Passaic River Study Area. As such, the AECOM (2010, 2011) document was utilized as a template for this survey task.

The need for current bathymetric data primarily stems from the need to support the hydrodynamic and sediment transport model being developed by the Cooperating Parties Group (CPG) pursuant to the Administrative Settlement Agreement and Order on Consent for Remedial Investigation/Feasibility Study (CERCLA 02-2007-2009) (USEPA 2007) for the Lower Passaic River Study Area. A secondary purpose for obtaining a current bathymetric dataset is to characterize changes in bathymetry due, in part, to the ongoing deepening work taking place in the NBSA as part of the Harbor Deepening Project which is deepening the navigation channels to approximately -50 ft Mean Lower Low Water. The changes in bathymetry that have occurred since the last survey of the NBSA will impact sediment transport and hydrodynamics in the system and the new survey data will support the conceptual site model (CSM) to reflect these significant changes in bathymetry. Multi-beam technology, which obtains depth data for a large swath of bottom, is proposed to develop a complete characterization of bottom topography. In addition, single-beam technology is proposed to collect data in areas that are too shallow for the multi-beam system. The proposed surveys will be performed as close as practicable to bridges and other in-water structures.

1.1 Site Background

As part of the AOC (USEPA 2004) for the NBSA, remedial investigations have been underway in Newark Bay (the Bay) since 2004 to assess the nature and extent of chemical contamination associated with a legacy of chemical releases in the region. The Bay, part of the New York/New Jersey Harbor Estuary, is located between the shores of Newark and Elizabeth to the west, Jersey City and Bayonne to the east, the confluence of the Passaic and Hackensack Rivers to the north, and Staten Island to the south. Newark Bay is linked to Upper New York Bay by the Kill van Kull, and to Raritan Bay by the Arthur Kill. For purposes of this QAPP, the NBSA is bound by:

- The Lower Passaic River Restoration Project downstream boundary
- The abandoned Conrail Bridge at the Hackensack River

- The Bayonne Bridge
- The Goethals Bridge

As part of the Phase I Remedial Investigation Work Plan (RIWP), a bathymetric survey was conducted using single-beam transects to accurately represent the depth and morphology of the Bay relative to known horizontal and vertical datums (Tierra 2005). The survey was conducted to define geomorphic areas and to assist field crews with sediment core collection since full-coverage bathymetric data had not been recently obtained for the Bay. The survey lines for the survey were placed at approximately 0.25-mile intervals and oriented perpendicular to the Bay with more closely spaced, shorter survey lines around shoreline structures, bridge crossings, and sharp breaks in the navigation channel banks. Additional tie-lines were run, as appropriate, to provide quality control data (Tierra 2005 and 2007).

1.2 Conceptual Site Model

An initial Conceptual Site Model (CSM) and a plan to update the CSM were developed to examine the assumed sources of contaminants, routes of environmental transport, contaminated media, routes of exposure, and receptors as part of the Phase I and II RIWPs (Tierra 2005, 2007, respectively). An Interim CSM was submitted in February 2011 (Tierra 2011) and is being revised. The data generated by the investigation described in this FSP will be used to support the updates to the CSM in addition to supporting the numerical model under development by the CPG.

1.3 Sampling Objectives

The development of the hydrodynamic and sediment transport model by the CPG requires a bathymetric dataset for the existing conditions of the NBSA to provide an accurate representation of the system. The bathymetry of the NBSA has changed since the original Phase I single-beam bathymetric survey conducted in 2005. Specifically, the navigation channels have undergone a significant deepening project to allow for larger vessels to arrive in the ports.

The combination of multi-beam and single-beam survey results will offer a more complete characterization of the NBSA bathymetry compared to the 2005 dataset and will support the CPG model development as well as ongoing remedial investigation activities at the site.

2. Field Activities

2.1 Survey Location

The survey area includes the entire NBSA with overlap into the Passaic River (Figure 1). Note that the survey plans were developed assuming high-tide conditions to maximize the coverage areas.

2.1.1 Multi-beam and Single-beam Surveys

The survey area will cover the entire NBSA and extend into the mouth of the Passaic River for completeness. The multi-beam survey will obtain complete coverage of the sediment floor and is planned to maximize the area covered by this technology. It is anticipated that water depths less than 6 feet (ft) and debris or obstructions will limit the use of the multi-beam technology. In some areas, it may be possible (pending USEPA approval) to utilize a "side-looking" methodology by tilting the multi-beam transducer to extend the multi-beam coverage. The proposed multi-beam survey will be performed as close as practicable to bridges and other in-water structures.

In areas which the multi-beam system cannot obtain data due to depth or other limitations, single-beam survey equipment will be deployed from a second vessel. The single-beam survey will be conducted along transects from the shallow-water extent of the multi-beam survey area into shallower water, with transects spaced approximately 100 ft apart, consistent with the work conducted along the Lower Passaic River (AECOM 2011). The transect spacing of 100 ft was based on a single-beam coverage that would supplement the complete coverage of the multi-beam survey and provide a higher resolution single-beam survey than the 2005 transect spacing of approximately 1520 ft. The single-beam transects will overlap the multi-beam coverage area by approximately 100 ft and extend to approximately 2 ft isobath.

The choice to utilize the tilted (side-looking) multi-beam method, following USEPA's approval for use, will be determined based on field observations and based upon agreement with USEPA or USEPA's representative. Generally, the field team will assess a given area with the following:

- The aerial extent (width) and submerged river bank slope angle of the fringe area
- The amount of debris or obstructions in a fringe or inter-pier area
- The complexity of the local water column sound speed profile.

Figure 2 presents the planned survey areas with anticipated survey technology. It should be noted that field conditions will determine the actual methodology for the survey coverage. Full bottom coverage (either by multi- or single-beam methodologies) may not be realized regardless of depth in areas encumbered by moored vessels, debris, etc.

2.2 Survey Equipment

The survey equipment proposed for use during this investigation includes both multi-beam and single-beam technology to allow for more complete coverage of the survey area compared to the single-beam survey that was conducted in 2005. The equipment that will be utilized includes the following (see Attachment 1 for specifications):

2.2.1 Multi-beam Equipment

1. *Multi-beam echosounder*: Reson 8125 Multi-beam echosounder system or equal. 455 kilohertz multi-beam system with 240 individual sounding beams in a 120-degree swath. Individual beams are 0.5-degree across track and 1.0-degree along track. Manufacturer's stated depth resolution is 6 millimeters.

2. *Global Positioning System (GPS) equipment*: Trimble Real Time Kinematic (RTK) GPS, including MS750 unit, 5700 base station and rovers, and associated telemetry radios including, but not limited, Pacific Crest radios operating at the appropriate frequencies and power outputs to meet project requirements.

3. *Data collection system and software*: high speed PC-based data collection platforms using the most recent stable version of Hypack/Hysweep for data collection.

4. *Inertial Positioning Equipment*: TSS-POSMV 320 Version 4 operating in RTK GPS mode.

5. *Heave, pitch, and roll compensation*: TSS-POSMV 320 Version 4 operating in RTK GPS mode with True Heave capability.

6. *Method for determining water surface elevation during the survey*: The vertical solution from the RTK GPS installed in the POSMV will be the primary method of water level determination. A Coastal Macro tide gage will be installed at the northeast corner of Port Elizabeth as a secondary water level device and will serve in a quality assurance/quality control capacity. The tide gage will be located in the horizontal according to the New Jersey State Plane coordinates and in the vertical to the National

Geodetic Vertical Datum of 1929 (NGVD29) based on existing survey control at Elizabeth Seaport, which was also utilized during the 2005 Phase I survey (Tierra 2005).

2.2.2 Single-beam Equipment

1. *Single-beam echosounder*: ODOM Hydrotrac single-beam echosounder operating at 200 kilohertz (+/- 10 percent) with a 3.5 or 8 degree beam angle transducer.

2. *GPS equipment*: same as for the multi-beam equipment discussed in Section 2.2.1.

3. *Data collection system and software*: same as for the multi-beam equipment discussed in Section 2.2.1.

4. *Heave, pitch, and roll compensation*: TSS DMS-05 heave compensator. To be utilized for heave component only; however, pitch and roll data will be collected and, if necessary, processed/used.

5. *Method for determining water surface elevation during survey*: The vertical solution from the Trimble MS750 RTK GPS will be the primary method of water level determination. The secondary/back-up water surface elevation data source will be the same as for the multi-beam equipment discussed in Section 2.2.1.

2.3 Survey Timing

This multi-beam and single-beam survey is planned to be conducted in late Fall/Winter 2012.

During survey activities the tidal cycle will play a key role in acquiring complete survey coverage. For the areas that are shallow (water depths less than approximately 6 ft), the survey collection is targeted to take place approximately 2.5 hours on either side of the high tide. For the deeper areas (water depths greater than or equal to 6 ft), the survey collection is targeted to take place during low tide conditions. Attachment 2 presents tide prediction charts to guide timing. It should be noted however that field conditions such as debris, other vessels, structures, or other obstacles may limit areas that can be reached by the survey vessels and will require the discretion of boat operators.

2.4 Detailed Survey Methodology

All survey work will be performed in accordance with the U.S. Army Corps of Engineers Hydrographic Survey Manual, EM 1110-2-1003 (USACE 2002), dated January 1, 2002, modified by April 1, 2004 updates to Chapter 11 for multi-beam surveying.

2.5 Health and Safety

A task-specific Health and Safety Plan (HASP) was developed for the NBSA (Tierra 2007). This HASP contains a hazard evaluation and hazard control methods specific to the on-water operations of this investigation. A task-specific HASP or addendum to the existing 2007 HASP will be generated (as appropriate) prior to this survey fieldwork and will be followed by all members of the survey and oversight teams.

3. Reporting

A field and data report will be prepared that will include the following:

- A summary of the field program including a description of any deviations from this FSP or the associated QAPP. The report will also include details on the quality evaluation conducted on the bathymetric data, including a discussion of precision and accuracy as well as an overall assessment of the quality of the survey.

- An electronic copy and file description of field notes, navigational data (survey lines), water surface elevation data, and processed data (ASCII X, Y, Z) with elevations referenced to NGVD29.

- Maps showing contours of the multi-beam data in AutoCAD format in reference to vertical datum NGVD29.

4. References

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Figures

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LEGEND:

- PHASE I/PHASE II SI STUDY AREA BOUNDARY
- FURTHEST EXTENT OF SURVEY AREA
- SHORELINE
- UNDERGROUND TRIBUTARY
- NBSA
- MOUTH OF PASSAIC RIVER

0 0.8 1.6 Miles

GRAPHIC SCALE

PASSAIC RIVER
HACKENSACK RIVER
ABANDONED CONRAIL BRIDGE
ABANDONED CONRAIL BRIDGE
PIERSONS CREEK
PORT NEWARK CHANNEL
ELIZABETH CHANNEL
NEWARK LIBERTY INTERNATIONAL AIRPORT
PERIPHERAL DITCH
NEWARK BAY CDF (CELL 1S)
SOUTH ELIZABETH CHANNEL
ELIZABETH RIVER
KILL VAN KULL
MORSES CREEK
GOETHALS BRIDGE
ARTHUR KILL
SHOOTERS ISLAND
BAYONNE BRIDGE
PILES CREEK
PRALLS ISLAND

NOTES:

1. HORIZONTAL DATUM: NEW JERSEY STATE PLANE COORDINATE SYSTEM, NAD83.
2. SHORELINE IS DIGITIZED FROM AERIAL PHOTO DATED JULY 2002 (INTRASEARCH, ENGLEWOOD, CO).
3. BASE MAP INFORMATION FROM NOAA CHARTS 12331, 12333, AND 12337, DATED MAY 4, 1995. PASSAIC NAVIGATION CHANNEL PROVIDED BY THE US ARMY CORPS OF ENGINEERS (USACE).

NEWARK BAY STUDY AREA REMEDIAL INVESTIGATION
FIELD SAMPLING PLAN
MULTI-BEAM AND SINGLE-BEAM BATHYMETRIC SURVEY

PROPOSED SURVEY AREAS

DECEMBER 2012

FIGURE
1

City: SYR Div/Group: IT Created By: K. SINSABAUGH Last Saved By: MKOHBERGER
Newark Bay (B0009989.0019.00001)
W:\GIS\Task\NBSA\BathymetrySurveyFieldSamplingPlan_2012_12_01\mxd\Survey Areas - OSI.mxd 12/3/2012 8:33:42 AM

LEGEND:

- PHASE I/PHASE II SI STUDY AREA BOUNDARY
- FURTHEST EXTENT OF SURVEY AREA
- SHORELINE
- UNDERGROUND TRIBUTARY

BATHYMETRY SURVEY AREAS:

- MULTI-BEAM BATHYMETRY SURVEY AREA
- MULTI-BEAM OR SINGLE-BEAM BATHYMETRY SURVEY AREA
- SINGLE-BEAM BATHYMETRY SURVEY AREA

0 0.8 1.6 Miles

GRAPHIC SCALE

PASSAIC RIVER
HACKENSACK RIVER
ABANDONED CONRAIL BRIDGE
ABANDONED CONRAIL BRIDGE
PIERSONS CREEK
PORT NEWARK CHANNEL
ELIZABETH CHANNEL
NEWARK LIBERTY INTERNATIONAL AIRPORT
PERIPHERAL DITCH
NEWARK BAY CDF (CELL 1S)
SOUTH ELIZABETH CHANNEL
ELIZABETH RIVER
KILL VAN KULL
MORSES CREEK
GOETHALS BRIDGE
BAYONNE BRIDGE
SHOOTERS ISLAND
ARTHUR KILL
PILES CREEK
PRALLS ISLAND

NOTES:

1. HORIZONTAL DATUM: NEW JERSEY STATE PLANE COORDINATE SYSTEM, NAD83.
2. SHORELINE IS DIGITIZED FROM AERIAL PHOTO DATED JULY 2002 (INTRASEARCH, ENGLEWOOD, CO).
3. BASE MAP INFORMATION FROM NOAA CHARTS 12331, 12333, AND 12337, DATED MAY 4, 1995. PASSAIC NAVIGATION CHANNEL PROVIDED BY THE US ARMY CORPS OF ENGINEERS (USACE).
4. MULTI-BEAM OR SINGLE-BEAM BATHYMETRY SURVEY AREAS WILL BE SURVEYED BY USING MULTI-BEAM TECHNOLOGY (DOWN-LOOKING OR SIDE-LOOKING) OR BY SINGLE-BEAM TECHNOLOGY. FIELD CONDITIONS SUCH AS WATER DEPTH AND DEBRIS WILL DETERMINE THE SPECIFIC METHODOLOGY.
5. SINGLE-BEAM BATHYMETRY SURVEY AREAS ARE ANTICIPATEDTO HAVE WATER DEPTHS OR DEBRIS FIELDS THAT WOULD BE UNSUITABLE FOR MULTI-BEAM EQUIPMENT.
6. SURVEY TECHNOLOGY TYPES ARE SUBJECT TO CHANGE BASED ON FIELD CONDITIONS.
7. PRELIMINARY SURVEY PLAN DEVELOPED BY OCEAN SURVEYS, INC.

NEWARK BAY STUDY AREA REMEDIAL INVESTIGATION
FIELD SAMPLING PLAN
MULTI-BEAM AND SINGLE-BEAM BATHYMETRIC SURVEY

PRELIMINARY SURVEY PLAN

DECEMBER 2012

FIGURE **2**

Attachment 1

Equipment Specifications
(provided separately as a
.zip file)

Attachment 2

Tide Prediction Charts

Tides-Port Elizabeth

based on New York NY, (NOAA)
40° 40.40 N 74° 8.40 W

December 2012

Average Tides
Mean Range: 5.1 ft
MHWS 6.2 ft
Mean Tide: 2.8 ft

Monthly High & Low
High December 13, 07:34 6.7 ft
Low December 14, 15:23 -1.3 ft

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
						1 (EST) SR:07:02 SS:16:30 03:44 0.4 / 09:18 5.3 / 16:30 0.2 / 22:16 4.4
2 (EST) SR:07:03 SS:16:30 04:18 0.5 / 09:51 5.2 / 17:07 0.3 / 23:01 4.3	3 (EST) SR:07:04 SS:16:30 04:52 0.7 / 10:30 5.0 / 17:44 0.4 / 23:44 4.3	4 (EST) SR:07:05 SS:16:30 05:28 0.8 / 11:15 4.9 / 18:25 0.6	5 (EST) SR:07:06 SS:16:30 00:26 4.3 / 06:18 1.0 / 12:05 4.8 / 19:19 0.6	6 (EST) SR:07:07 SS:16:30 01:10 4.5 / 07:37 1.0 / 12:59 4.7 / 20:21 0.5	7 (EST) SR:07:08 SS:16:30 01:58 4.8 / 08:55 0.8 / 13:57 4.6 / 21:20 0.3	8 (EST) SR:07:09 SS:16:30 02:53 5.1 / 09:59 0.5 / 15:02 4.6 / 22:15 0.1
9 (EST) SR:07:10 SS:16:30 03:53 5.4 / 10:56 0.1 / 16:13 4.7 / 23:07 -0.2	10 (EST) SR:07:10 SS:16:30 04:53 5.9 / 11:51 -0.3 / 17:19 4.9	11 (EST) SR:07:11 SS:16:30 00:00 -0.5 / 05:50 6.3 / 12:46 -0.7 / 18:17 5.1	12 (EST) SR:07:12 SS:16:30 00:53 -0.8 / 06:43 6.6 / 13:40 -1.0 / 19:11 5.3	13 (EST) SR:07:13 SS:16:30 01:47 -0.9 / 07:34 6.7 / 14:32 -1.2 / 20:04 5.4	14 (EST) SR:07:13 SS:16:31 02:40 -1.0 / 08:26 6.7 / 15:23 -1.3 / 20:59 5.4	15 (EST) SR:07:14 SS:16:31 03:32 -0.8 / 09:20 6.5 / 16:12 -1.3 / 21:57 5.4
16 (EST) SR:07:15 SS:16:31 04:23 -0.7 / 10:18 6.2 / 17:01 -1.0 / 22:57 5.3	17 (EST) SR:07:15 SS:16:31 05:15 -0.4 / 11:16 5.8 / 17:52 -0.7 / 23:54 5.2	18 (EST) SR:07:16 SS:16:32 06:11 0.0 / 12:11 5.4 / 18:45 -0.4	19 (EST) SR:07:17 SS:16:32 00:48 5.1 / 07:13 0.4 / 13:05 5.0 / 19:42 0.0	20 (EST) SR:07:17 SS:16:33 01:41 4.9 / 08:18 0.6 / 13:58 4.7 / 20:39 0.2	21 (EST) SR:07:18 SS:16:33 02:34 4.9 / 09:21 0.7 / 14:54 4.4 / 21:33 0.3	22 (EST) SR:07:18 SS:16:34 03:28 4.8 / 10:17 0.6 / 15:52 4.2 / 22:23 0.3
23 (EST) SR:07:19 SS:16:34 04:24 4.9 / 11:08 0.5 / 16:50 4.2 / 23:10 0.3	24 (EST) SR:07:19 SS:16:35 05:15 5.0 / 11:56 0.3 / 17:42 4.2 / 23:55 0.2	25 (EST) SR:07:19 SS:16:36 06:01 5.1 / 12:42 0.2 / 18:29 4.4	26 (EST) SR:07:20 SS:16:36 00:39 0.1 / 06:43 5.3 / 13:27 0.0 / 19:11 4.4	27 (EST) SR:07:20 SS:16:37 01:23 0.1 / 07:20 5.4 / 14:10 -0.2 / 19:52 4.5	28 (EST) SR:07:20 SS:16:38 02:06 0.0 / 07:55 5.4 / 14:51 -0.3 / 20:31 4.5	29 (EST) SR:07:21 SS:16:38 02:46 0.0 / 08:28 5.4 / 15:30 -0.3 / 21:09 4.5
30 (EST) SR:07:21 SS:16:39 03:25 0.0 / 08:59 5.3 / 16:06 -0.3 / 21:48 4.5	31 (EST) SR:07:21 SS:16:40 04:02 0.1 / 09:31 5.2 / 16:41 -0.2 / 22:26 4.5					

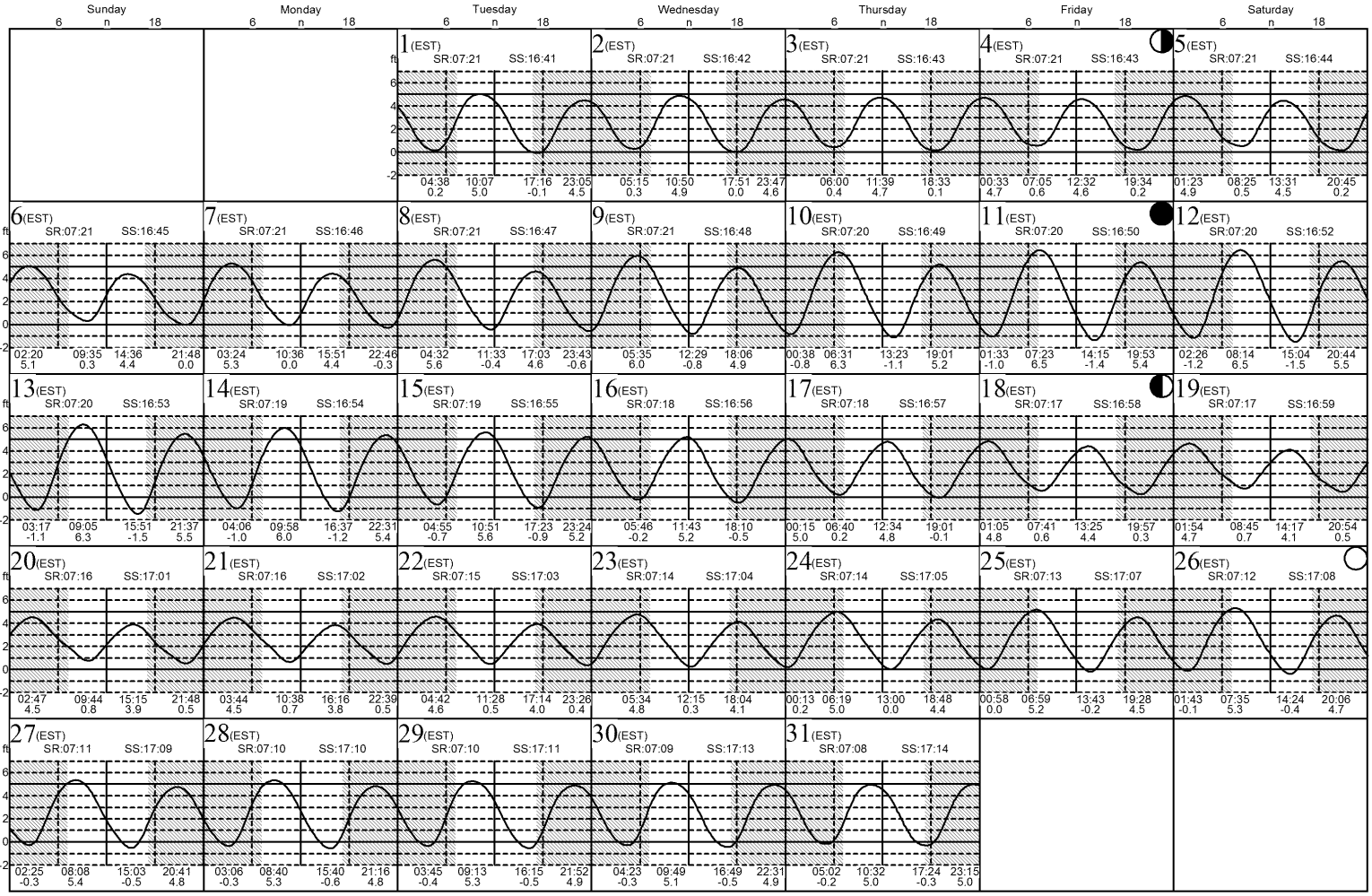
Tides-Port Elizabeth

based on New York NY, (NOAA)
40° 40.40 N 74° 8.40 W

January 2013

Average Tides
Mean Range: 5.1 ft
MHWS 6.2 ft
Mean Tide: 2.8 ft

Monthly High & Low
High January 12, 08:14 6.5 ft
Low January 12, 15:04 -1.5 ft



Appendix B

Field Standard Operating Procedures

Standard Operating Procedure No. 1

Field Documentation

December 2012

Revision 1

1. Purpose and Scope

The purpose of this document is to define the standard operating procedure (SOP) for documentation of field activities associated with the Quality Assurance Project Plan (QAPP) for Newark Bay Study Area: Multi-beam and Single-beam Bathymetric Survey (Tierra Solutions, Inc. 2012). Appropriate documentation of field activities provides an accurate and comprehensive record of the work performed, sufficient for a technical peer to reconstruct the day's activities and determine that necessary requirements were met, without relying on the collector's memory.

This SOP may change depending upon field conditions or limitations imposed by the procedure. Substantive modification to this SOP shall be approved in advance by the Project Coordinator and the U.S. Environmental Protection Agency Remedial Project Manager. The ultimate procedure employed will be documented in the Final Work Plan prior to the start of work.

Other SOPs will be utilized in conjunction with this procedure:

- SOP No. 2 – Data Management
- SOP No. 3 – Tide Gage Installation
- SOP No. 4 – Multi-beam Bathymetric Surveying
- SOP No. 5 – Single-beam Bathymetric Surveying

2. Procedures

In all instances where this SOP will be utilized, a hard copy or electronic version will be available at the point of use.

2.1 General Procedures

Pertinent field information will be recorded in a logbook and/or an appropriate form (as described herein) in black, ballpoint pen. If weather conditions do not allow for a ballpoint pen to be used, a thin-tipped Sharpie®, or equivalent, may be used. Alternatively, electronic methods of recording field information may be utilized. All content and guidance for the logbook/form documentation can apply, as appropriate, to electronic logs at the discresion of the field staff. If field records are being kept electronically, an appropriate backup procedure will be implemented. At a minimum, the procedure will include saving data to a removable storage device (i.e., flash drive, external hard drive, etc.) at mid-day and at the end of each day. The backup device(s) will be stored in a location separate from the laptop or primary recording device.

A key that describes each entry is provided for the forms. Logbook entries will be factual and observational (i.e., no speculation or opinion), and will not contain any

personal information or non-project-related entries. Separate and dedicated logbooks will be kept for different operations running concurrently; individual tasks making up each operation will be maintained in the same logbook, if possible. The cover and binding of each logbook will be labeled to identify the operation and dates included within the logbook; each page in the logbook will be consecutively numbered.

A page header will appear on the first page of each day's notes in the logbook, and activities for each day will be recorded on a new page. The page header will include:

- name of author and other personnel on site (and affiliated organization if applicable)
- date
- time of arrival
- current weather and tidal conditions, and weather forecast for the day

An abbreviated header, limited to the date, will appear at the top of each additional page for the active date. The Daily Activity Log (see attachment) will require similar header information.

Field activities and other events pertinent to the field activities will be documented in chronological order at the time of occurrence, to the extent possible. Any entries recorded significantly after the fact will be dated as such. Times will be recorded using 24-hour notation for each entry. At a minimum, documentation in a logbook will include the following:

- names of visitor(s) to the work location being documented in the logbook, including time of arrival and departure, the visitor's affiliation, and reason for visit
- summary of project-related communications, including names of people involved and time
- time daily work commences and ceases
- start and stop times of new tasks
- start and stop times of breaks
- safety or other monitoring data, including units with each measurement
- deviations from scope of work

- progress updates
- problems/delays encountered
- unusual events
- signature or initials of author on every page

A single line will be drawn through incorrect entries and the corrected entry written next to the original strikeout. Strikeouts are to be initialed and dated by the originator.

If there are additional lines on the page at the end of the day's activities, a line will be drawn through the empty space, initialed, and dated, leaving no room for additional entries.

The logbook will cross-reference information documented in the field forms.

Photographs will be identified in the logbook by a unique numbering system. If photographs are collected by a digital camera, the file number as well as the photograph number will accompany the description of the photograph in the logbook. At a minimum, the time the photograph was taken, the general location, a brief description, and the photographer's name will be recorded. Additional information may include: Differential Global Positioning System coordinates, direction the photographer was facing, and/or weather conditions. If necessary, an object will be included to indicate the scale of the object in the photograph.

Any electronic files used for recording the field observations will have a file saved each day (not including the backup file procedure) with an identifier that includes the date and a description of the file contents. For example for this bathymetric survey work: "YYYYMMDD_FieldNotes". The file will be saved in Portable Document Format for the official project file.

2.2 Additional Requirements for Field Activities

This section presents specific documentation requirements for activities to be performed. It is meant to provide guidance to project staff responsible for field documentation during these activities, and is not intended to be a comprehensive list of activities performed. These documentation procedures are meant to supplement, not replace, the required documentation presented in Section 2.1.

As noted in Section 2.1, a Daily Activity Log was developed for the bathymetric survey to ensure proper documentation of field information is obtained in a consistent manner. Once completed, this log provides a summary of daily vessel logistics during the bathymetric survey activities, including personnel present, equipment used, and weather conditions. This log is provided as an Attachment to this SOP.

2.2.1 Bathymetric Survey

Information regarding the bathymetric survey activities will be recorded in the Daily Activity Log. If any procedural modifications must be implemented, the proposed change must be communicated through the project team (see QAPP for communication pathways) for USEPA approval. No procedural modifications will take place before the methods are approved. A memorandum will be developed to document the approved modifications.

2.2.2 Equipment Calibration and Maintenance

Equipment calibration will be recorded in the equipment calibration logbook. Instrument information, including the instrument manufacturer, model number, and serial number, will be recorded. Instrument calibration will be performed in accordance with manufacturer's specifications, and at the frequency specified by the manufacturer's specifications. Values measured during calibration will be recorded in the equipment calibration logbook. In addition, maintenance, problems, and repairs to the equipment will be recorded in the equipment calibration logbook.

2.3 Distribution and Maintenance of Field Documentation

Logbooks and field forms will be filed according to the QAPP and SOP No. 2 – Data Management.

Logbooks that are taken off site from the field offices will be photocopied and filed at the end of each day to mitigate against the loss of historical entries should the logbook be lost in the field.

Field data forms will be filed once they have been completed and distributed (if necessary), or at the end of each field day.

Electronically recorded field information will be e-mailed to the Bathymetry/Data Management Task Manager at the end of each day for official project filing and backup.

Distribution of daily forms will be performed according to the needs of the project team and at the direction of the Project Coordinator or designee.

3. Quality Assurance

The personnel that are recording the field notes are to have reviewed the QAPP and supporting documentation and are to be familiar with the goals and procedures for task completion.

Entries in the field forms will be double-checked by the field crew to verify the information is correct. Completed field forms will be reviewed periodically by the Project

Coordinator and/or Project Quality Assurance Manager or their designee(s) to verify that the requirements are being met.

4. Reference

Tierra Solutions, Inc. 2012. Quality Assurance Project Plan for Newark Bay Study Area: Multi-beam and Single-beam Bathymetric Survey. Revision 1. December.

5. Revision History

Revision	Date	Changes
0	November 2012	NA
1	December 2012	Addressed USEPA comments, as presented in Tierra's response to comments submitted 11/29/2012 and Tierra's follow-up e-mail to USEPA dated 11/30/2012. USEPA's acceptance of Tierra's responses to comments provided in an e-mail dated 11/30/2012.

DAILY ACTIVITY LOG
MULTI-BEAM AND SINGLE-BEAM BATHYMETRIC SURVEY
(Sheet 1 of 2)

Date of Field Work[1]: _____

Person Responsible for Log[2]: _____

Vessel Name/Owner of Vessel Performing Work[3]: _____

List personnel on board vessel, affiliation, and role (if more room is needed, continue in the field logbook):

_____

_____

_____

_____

_____

_____

Time of Daily Health and Safety Tailgate Meeting and Form Completion[4]: _____

Weather Conditions and Forecast[5]: _____

Time of High Tide/Low Tide[6]:_____

EQUIPMENT SUMMARY[7]:

Equipment Name	Serial Number or Unique Identifier	Daily Calibrations/Performed By	Other Calibrations
Reson 8125			
POS-MV			
Trimble MS750			
Trimble 5700			
Pacific Crest PDL			
Seabird SBE 19			
Seabird SBE 37			
Coastal Macro Tide Gage			

Time of Departure from Marina at Beginning of Day: _____

Time of Return to Marina at End of Day: _____

** If more room is needed, record information in field logbook and provide a copy of any notes in field logbook with this form**

DAILY ACTIVITY LOG KEY
MULTI-BEAM AND SINGLE-BEAM BATHYMETRIC SURVEY
(Sheet 2 of 2)

Description of Items:

(1) Date of activity (e.g., 12/1/2012).

(2) Name of person entering information into this form.

(3) Name of vessel performing activity.

(4) Enter time (24-hour format) that Health and Safety Tailgate Meeting was held in the morning. Tailgate form from the Health and Safety Plan should be filled out and archived with this Daily Activity Log each day.

(5) Weather forecast checked via marine radio, Newark Liberty International Airport, etc.

(6) Time of High and Low Tide for the day checked via the National Oceanic and Atmospheric Administration's website.

(7) Equipment details are provided in the FSP. Calibration details/schedules provided in the QAPP.

(8) Time of departure from the marina at the beginning of the day (24-hour format).

(9) Time of return to the marina at the end of the day (24-hour format).

(10) Name of person entering information into this form.

Standard Operating Procedure
No. 2

Data Management

December 2012

Revision 1

1. Purpose and Scope

The purpose of this document is to define the standard operating procedure (SOP) for documentation of field activities associated with the Quality Assurance Project Plan (QAPP) for Newark Bay Study Area: Multi-beam and Single-beam Bathymetric Survey (Tierra Solutions, Inc. 2012). This SOP describes the procedures necessary to manage the survey data.

Substantive modification to this SOP will be approved in advance by the Project Coordinator and the U.S. Environmental Protection Agency (USEPA) Remedial Project Manager. The ultimate procedure employed will be documented in the Final Work Plan prior to the start of work.

Other SOPs will be utilized in conjunction with this procedure:

- SOP No. 1 – Field Documentation
- SOP No. 3 – Tide Gage Installation
- SOP No. 4 – Multi-beam Bathymetric Surveying
- SOP No. 5 – Single-beam Bathymetric Surveying

2. Procedures

In all instances where this SOP will be utilized, a hard copy or electronic version will be available at the point of use.

2.1 Data Handling and Management

The following sections trace the paths of data from generation to final use and storage, as well as the associated quality checks for error detection that are performed to promote data integrity. Note that no samples will be collected as part of this survey; all data will be recorded electronically and field notations/observations will be associated with quality control and safety procedures.

2.1.1 Data Recording

2.1.1.1 Field

Data and information collected in the field through visual observation or measurement may be recorded using electronic methods such as a Personal Digital Assistant,

laptop, or equivalent, or associated logbooks and forms, and will be recorded in accordance with requirements as described in SOP No. 1 – Field Documentation.

2.1.1.2 Field Data Checking

At the end of each working day, a field team member will forward the field information generated from the current day's activities to an office team member via scan and e-mail so that the information (e.g., forms, logbooks, electronic data, photos) may be checked for completeness and clarity. Completeness will be determined by verifying that there are no missing data or information. The field crew will verify that the data and information that are collected electronically are being recorded accurately during collection and then perform a review of the data and information at the end of each day, prior to daily delivery to the Bathymetry/Data Management Task Manager (see SOP No. 1 – Field Documentation) for accuracy of the information that was recorded. Accuracy will be based upon review of the recorded information and upon resolving any questions that arise during this review.

Note that if there are any deviations from the QAPP guidelines, these must be immediately communicated with the project team, including the Bathymetry/Data Management Task Manager and the Project Quality Assurance Manager. In addition, the deviations, reasons for the deviations, and corrections/final decisions from the project team will be noted in the field logs.

All completed activity logs and Health and Safety Tailgate forms will be completed in accordance with the site-specific Health and Safety Plan and will be kept by the field representative in a binder until the fieldwork is completed. The completed binder will be handled in accordance with hard copy management, described in Section 2.2.1.

2.1.1.2 Weekly Report

Once the field documentation has been checked, a Weekly Report will be generated by an office team member and provided to the Project Coordinator for review and comment, which will include the daily activity logs, daily Health and Safety Tailgate forms, and any field notes/observations recorded in the field notes. Upon approval by the Project Quality Assurance Manager, the Weekly Report will be provided to the project team, as necessary

2.2 Data Tracking and Control

The following sections discuss the procedures for data tracking, storage, archiving, retrieval, and security for both hard copy and electronic data and information.

2.2.1 Data Storage, Archiving, and Retrieval

2.2.1.1 Hard-Copy Files

Hard copies of project documentation and data will be placed in the Newark Bay project file, parts of which will exist in several locations, including:

- ARCADIS, Syracuse, New York
- Tierra, East Brunswick, New Jersey.

Such files will be maintained in secure locations within each facility. Hard copies of project documentation and data will be provided to USEPA upon request.

Duplicate copies of pertinent field-related correspondence/documentation will be maintained at the field office during field operations. Once such field operations have been completed, this documentation will be transferred to the project file.

At such time that it is deemed appropriate to archive the project file, either in parts or in its entirety, files will be placed into boxes and shipped off site to a secure document storage facility. The assigned barcode identifier for each box being archived will be logged into a tracking spreadsheet along with a brief description of the contents of the box. Archived boxes will be retrieved from the document storage facility if/when necessary using the logged barcode identifier.

2.2.1.2 Electronic Files

Electronic data and information will be maintained and managed by the entities listed above using password-protected computers and on secure network drives with access limited to project personnel. Files will generally consist of the same components as the hard-copy files. Reports and field data will be in Portable Document Format (or equivalent).

2.2.2 Data Security

Hard-copy information/data will be stored in secure areas within the two Newark Bay project file locations. Electronic data and information will be maintained and managed using password-protected computers and on secure network drives with access limited to project personnel.

3. Quality Assurance

Appropriate quality assurance/quality control procedures will be followed during data management in accordance with the QAPP (Tierra 2012), SOP No. 1 – Field Documentation, and this SOP.

4. Documentation

Field documentation will be maintained in accordance with the QAPP (Tierra 2012), SOP No. 1 – Field Documentation, and this SOP.

5. Reference

Tierra. 2012. Quality Assurance Project Plan for Newark Bay Study Area: Multi-beam and Single-beam Bathymetric Survey. Revision 1. December.

Standard Operating Procedure
No. 3

Tide Gage Installation

December 2012

Revision 1

1. Purpose and Scope

The purpose of this document is to define the standard operating procedure (SOP) for documentation of field activities associated with the Quality Assurance Project Plan (QAPP) for Newark Bay Study Area: Multi-beam and Single-beam Bathymetric Survey (Tierra Solutions, Inc. 2012). This SOP describes the equipment, field procedures, materials, and documentation procedures necessary to install a tide gage.

This SOP may change depending on field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP shall be approved in advance by the Project Coordinator and the U.S. Environmental Protection Agency Remedial Project Manager. The ultimate procedure employed will be documented in the Field Report.

One other SOP will be utilized in conjunction with this procedure:

- SOP No. 1 – Field Documentation

2. Procedures

In all instances where this SOP will be utilized, a hard copy or electronic version will be available at the point of use.

2.1 Equipment List

The following equipment list contains materials which may be needed in carrying out the procedures contained in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- personal protective equipment and other applicable safety equipment
- navigation charts
- appropriate equipment and hardware for installing the tide gage
- tide gage and tide staff
- logbook or electronic equivalent
- permanent marker or grease pencil

2.2 Installation Procedures

This section presents the general procedures for tide gage installation. Specific installation procedures will vary given the type of gage being installed, the location, and the structure to which the gage is being attached.

The tide gage will be a commercially available unit and will be installed according to the instructions provided by the manufacturer. A stilling well, or equivalent device, will be installed to minimize the effect of non-tidal water level fluctuation (induced by boat traffic or winds), if necessary. A tide staff will be installed with the tide gage in such a way that the water surface elevations are measured consistently between each device.

Appropriate access authorization will be obtained prior to installing the tide gage to a bridge pier, bulkhead, or similar anchoring point. The gage will be secured to a bridge pier, bulkhead, or similar anchoring point so that the gage cannot be moved laterally or vertically. Following installation, the gage will be surveyed for vertical location from a third order benchmark or better (within 0.01-foot accuracy). The gage elevation will be established to 0.01 foot in the National Geodetic Vertical Datum of 1929. The gage will also be surveyed for horizontal location (within 1-foot accuracy), established in the New Jersey State Plane Coordinate System, with respect to the North American Datum of 1983.

3. Quality Assurance

Appropriate quality assurance/quality control procedures will be followed during the surveying of each tide gage location and elevation, including the use of horizontal and vertical control points. The survey work will meet a minimum of third order vertical accuracy for conventional traverse. A level loop and the closing error will be recorded, along with the benchmark sets. In addition, the following items will be checked during the installation process:

- security of the mounting system, eliminating the possibility of gage movement
- clock/time accuracy (referenced to Coordinated Universal Time [UTC])
- setting of a time-mark on the tide gage (i.e., noting the exact time in the logbook that the tide gage is placed in the water).

4. Documentation

Field notes will be kept during installation activities in accordance with SOP No. 1 – Field Documentation. In addition, the following information should also be included in the logbook (at a minimum):

- date and time of installation
- location of the gage in New Jersey State Plane Coordinate System (feet), and brief description of the vicinity
- for a pressure gage, record distance (feet) from the pressure transducer to the vertical datum
- specifications of gage (manufacturer, model, serial number, and user-selectable settings)
- installation method
- unusual conditions or problems with installation
- time that installation was completed
- vertical datum and control points.

5. References

Tierra Solutions, Inc. 2012. Quality Assurance Project Plan for Newark Bay Study Area: Multi-beam and Single-beam Bathymetric Survey. Revision 1. December.

Standard Operating Procedure No. 4

Multi-beam Bathymetric Surveying

December 2012

Revision 1

1. Purpose and Scope

The purpose of this document is to define the standard operating procedure (SOP) for documentation of field activities associated with the Quality Assurance Project Plan (QAPP) for Newark Bay Study Area: Multi-beam and Single-beam Bathymetric Survey (Tierra Solutions, Inc. 2012). This SOP provides descriptions of equipment, field procedures, and documentation necessary to conduct the multi-beam survey. The objectives and locations of the bathymetric survey are discussed in the QAPP.

This SOP may change depending upon field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP shall be approved in advance by the Project Coordinator, and U.S. Environmental Protection Agency Remedial Project Manager. The ultimate procedure employed will be documented in the Survey Report.

Other SOPs will be utilized in conjunction with this procedure:

- SOP No. 1 – Field Documentation
- SOP No. 2 – Data Management
- SOP No. 3 – Tide Gage Installation

2. Procedures

In all instances where this SOP will be utilized, a hard copy or electronic version will be available at the point of use.

2.1 Equipment List

The following equipment list contains materials which may be needed in carrying out the procedures contained in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- personal protective equipment and other applicable safety equipment
- survey vessel adequate for conditions in Newark Bay
- fathometer for boat operations with a resolution of 0.1 foot
- Real Time Kinematic Global Positioning System (RTK GPS) including a base station and a rover receiver and external antenna

- calibration plate
- navigation, plotting, and computer equipment
- logbook and location map
- multi-beam surveying equipment

2.2 Procedure

Multi-beam bathymetric soundings will be collected across the deepest areas of the NBSA. Transect survey lines will be positioned to maximize the multi-beam swath to develop complete bottom coverage of the areas surveyed using multi-beam technology. Method-specific check lines will be performed for quality check purposes.

One tide gage will be installed within Newark Bay prior to surveying. The gage will be installed according to SOP No. 3 – Tide Gage Installation.

Bathymetry measurements in the shallower areas (water depths to approximately 6 ft), such as sub-tidal flats, will be collected during high-water periods. High-water periods will be classified as the period ranging from approximately 2.5 hours prior to the predicted high tide until approximately 2.5 hours after the predicted high tide, subject to the boat captain's assessment of boat and equipment safety. Conducting the survey during high-water periods will allow measurements to be taken over the shallow, sub-tidal flats of Newark Bay, as well as the deeper sections. Bathymetry measurements in the deeper navigation channels and transitional slopes may be performed at any time. The tide level will be recorded as described in Section 4 (below) during the time period the measurements are made.

In the areas where water depth is shallow, the multi-beam equipment has the capability to be tilted to perform a "side-looking" survey, which will extend the area of coverage using this technology. This arrangement is anticipated to be most useful in shallow areas (i.e., < 6 ft water) that are narrow in lateral extent. The minimum water depth for data collection is approximately 2 ft. Note that the tilted (side-looking) multi-beam methodology is only to be performed following USEPA's approval of field-verification performance testing, which is planned to be conducted prior to survey work.

A RTK GPS base station will be established over a shore-based point referenced to survery control provided by the Port Authority of New York and New Jersey prior to survey operations. RTK GPS corrections transmitted to the survey vessel from the base station will allow for the collection of real-time, precision water-level data at the

survey vessel during bathymetric data collection. The operation and horizontal/vertical accuracy of the vessel-mounted RTK GPS, will be verified at another USACE monument or temporary benchmark by recording the observed horizontal and vertical (XYZ) data and comparing these data to the known position for that point.

Calibration checks of the fathometer will occur a minimum of twice each day – once before work commences and once after completing the day's activity.

Each survey line recording will be labeled with the survey line number, direction of travel, date, time, and the name of the fathometer operator.

Upon completion of field activities, the profiles will be adjusted using tide data so that depth data are reported relative to the National Geodetic Vertical Datum of 1929.

2.3 Bathymetric Survey – General Specifications

The accuracy of the bathymetry survey will meet or exceed the USACE Class 1 Hydrographic Survey Standard (USACE 2002). The following are general specifications for the bathymetric survey:

1. Survey Vessel – Adequate for conditions in Newark Bay and capable of supporting the bathymetric positioning and sampling equipment.

2. Vessel Positioning – Horizontal positioning system capable of at least +/-1 foot accuracy.

3. Vessel Navigation – Navigation system made up of computer-based software providing: display of vessel position relative to intended survey lines (with right/left helmsman indicator), navigation channel limits, aids to navigation, shoreline, and other features. Computer and software (such as Hypack®) will be capable of displaying a colorized plan view depth display as acquired (i.e., real-time basis) for the purpose of quality assurance/quality control and to log both vessel position and digital depth data.

4. Soundings – Multi-beam fathometer should be capable of 455 kHz with 240 individual sounding beams in a 120-degree swath. Multi-beam soundings will be logged continuously along each survey line. The fathometer will be calibrated for water mass sound speed using a Seabird SBE 19 CTD.

Horizontal control for the project will be established from published monuments located along the banks of Newark Bay.

Vertical control information will be shown on drawings and charts produced.

Despite virtually worldwide, 24-hour coverage, technical difficulties with GPS satellites sometimes occurs. In the event of system-wide or other long-term problems with GPS (e.g., satellite failures), survey vessel positioning will be achieved using land-based methods. If a land-based method is selected, an SOP will be developed for its use.

2.4 Decontamination

Survey and sounding equipment that has been immersed in Newark Bay waters will be cleaned/decontaminated in accordance with manufacturer requirements.

3. Quality Assurance

The fathometer and RTK GPS receivers will be operated and maintained in accordance with the manufacturers' operating manuals. Field instruments will be used by experienced operators familiar with field procedures and manufacturers' instructions.

The vessel-mounted RTK GPS system performance will be verified daily prior to, and after, survey activities using a temporary survey point. Vessel position during the bathymetry survey will be checked using computer software (such as Hypack®). Procedures for field documentation and data management are presented in SOP 1 – Field Documentation and SOP No. 2 – Data Management.

4. Documentation

The documentation requirements for the field personnel will include recording observations made during profiling that could affect the quality of the data. Complete field documentation procedures are presented in SOP No. 1 – Field Documentation.

In addition, the following information will be recorded in a digital or hardcopy logbook (at a minimum):

- survey line number
- direction of travel
- date
- time (Coordinated Universal Time [UTC])

- time of high tide (UTC)
- profiling equipment (i.e., brand, model, and serial number)
- equipment calibration (bar check results)
- unusual conditions
- brief description of the area around the survey line location and the weather conditions at the time of profiling
- description of transect beginning and end points

5. References

Tierra Solutions, Inc. 2012. Quality Assurance Project Plan for Newark Bay Study Area: Multi-beam and Single-beam Bathymetric Survey. Revision 1. December.

U.S. Army Corps of Engineers. 2002. Engineering and Design – Hydrographic Surveying. EM 1110-2-1003 Modified April 2004. Available online: http://publications.usace.army.mil/publications/eng-manuals/EM_1110-2-1003_pfl/toc.htm.

Standard Operating Procedure No. 5

Single-beam Bathymetric Surveying

December 2012

Revision 1

1. Purpose and Scope

The purpose of this document is to define the standard operating procedure (SOP) for documentation of field activities associated with the Quality Assurance Project Plan (QAPP) for Newark Bay Study Area: Multi-beam and Single-beam Bathymetric Survey (Tierra Solutions, Inc. 2012). This SOP provides descriptions of equipment, field procedures, and documentation necessary to conduct the single-beam survey. The objectives and locations of the bathymetric survey are discussed in the QAPP.

This SOP may change depending upon field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP shall be approved in advance by the Project Coordinator, and U.S. Environmental Protection Agency Remedial Project Manager. The ultimate procedure employed will be documented in the Survey Report.

Other SOPs will be utilized in conjunction with this SOP, including:

- SOP No. 1 – Field Documentation
- SOP No. 2 – Data Management
- SOP No. 3 – Tide Gage Installation

2. Procedures

In all instances where this SOP will be utilized, a hard copy or electronic version will be available at the point of use.

2.1 Equipment List

The following equipment list contains materials which may be needed in carrying out the procedures contained in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- personal protective equipment and other applicable safety equipment
- survey vessel adequate for conditions in Newark Bay
- fathometer for boat operations with a resolution of 0.1 foot
- Real Time Kinematics Global Positioning System (RTK GPS) including a base station and a rover receiver and external antenna

- calibration plate
- navigation, plotting, and computer equipment
- logbook and location map
- single-beam surveying equipment

2.2 Procedure

Single-beam bathymetric soundings will be collected in the shallow areas of the NBSA where the multi-beam survey could not be conducted, or, if the multi-beam "side-looking" survey could not reach. The survey lines for the single-beam survey will be spaced approximately every 100 feet shoreward of the edge of the multi-beam coverage area. The survey lines will obtain data from water depths of approximately 2 feet and overlap the multi-beam coverage area by approximately 100 feet. More closely-spaced, shorter survey lines may also be positioned around shoreline structures, bridge crossings, and sharp grade breaks in the navigation channel banks, as necessary. Survey lines for single-beam surveying will be determined once the multi-beam survey area has been determined. Method-specific check lines will be performed for quality check purposes.

One tide gage will be installed within Newark Bay prior to surveying. The gage will be installed according to SOP No. 3 – Tide Gage Installation.

Single-beam bathymetry measurements in the shallow areas, along the sub-tidal flats, will be collected during high-water periods if boat draft limitations are anticipated. High-water periods will be classified as the period ranging from approximately 2.5 hours prior to the predicted high tide until approximately 2.5 hours after the predicted high tide, subject to the boat captain's assessment of boat and equipment safety. Conducting the single-beam survey during high-water periods will allow measurements to be taken over the shallow, sub-tidal flats of Newark Bay. The tide level will be recorded as described in Section 4 (below) during the time period the measurements are made.

A RTK GPS base station will be established over a shore-based point referenced to survey control provided by the Port Authority of New York and New Jersey prior to survey operations. RTK GPS corrections transmitted to the survey vessel from the base station will allow for the collection of real-time, precision water level data at the survey vessel during bathymetric data collection. The operation and horizontal/vertical accuracy of the vessel mounted RTK GPS, mounted directly above the single-beam transducer, will be verified at another USACE monument or temporary benchmark by

recording observed horizontal and vertical (XYZ) data and comparing these data to the known position for that point.

Calibration checks of the fathometer will occur a minimum of twice each day – once before work commences and once after completing the day's activity.

Each survey line recording will be labeled with the survey line number, direction of travel, date, time, and the name of the fathometer operator. At a minimum, this information will be recorded in the electronic project log.

Upon completion of field activities, the profiles will be adjusted using tide data so that depth data are reported relative to the National Geodetic Vertical Datum of 1929.

2.3 Bathymetric Survey – General Specifications

The accuracy of the bathymetry survey will meet or exceed the USACE Class 1 Hydrographic Survey Standard (USACE 2002). The following are general specifications for the bathymetric survey:

1. Survey Vessel – Adequate for conditions in Newark Bay and capable of supporting the bathymetric positioning and sampling equipment.

2. Vessel Positioning – Horizontal positioning system capable of at least +/-1 foot accuracy.

3. Vessel Navigation – Navigation system made up of computer-based software providing: display of vessel position relative to intended survey lines (with right/left helmsman indicator), navigation channel limits, aids to navigation, shoreline, and other features. Computer and software (such as Hypack®) will be capable of displaying the cross-section data as acquired (i.e., real-time basis) for the purpose of quality assurance/quality control and to log both vessel position and digital depth data.

4. Soundings – Fathometer should be capable of 200 kilohertz sounding frequency, with a resolution of 0.1 foot. Soundings will be logged at approximately 0.1-second time intervals or at about 2-foot distance intervals along each survey line. The fathometer will be calibrated for water mass sound speed using standard bar check procedures.

Horizontal control for the project will be established from published monuments located along the banks of Newark Bay.

Vertical control information will be shown on drawings and charts produced.

Despite virtually worldwide, 24-hour coverage, technical difficulties with GPS satellites sometimes occur. In the event of system-wide or other long-term problems with GPS (e.g., satellite failures), survey vessel positioning will be achieved using land-based methods. If a land-based method is selected, an SOP will be developed for its use.

2.4 Decontamination

Survey and sounding equipment which has been immersed in Newark Bay waters will be cleaned/decontaminated in accordance with manufacturer requirements.

3. Quality Assurance

The fathometer and RTK GPS receivers will be operated and maintained in accordance with the manufacturers' operating manuals. Field instruments will be used by experienced operators familiar with field procedures and manufacturers' instructions.

The vessel-mounted RTK GPS system performance will be verified daily prior to and after survey activities using a temporary survey point. Vessel position during the bathymetry survey will be checked using computer software (such as Hypack®). Procedures for field documentation and data management are presented in SOP 1 – Field Documentation and SOP No. 2 – Data Management.

4. Documentation

The documentation requirements for the field personnel will include recording observations made during profiling that could affect the quality of the data. Complete field documentation procedures are presented in SOP No. 1 – Field Documentation.

In addition, the following information will be recorded in a digital or hardcopy logbook (at a minimum):

- survey line number
- direction of travel
- date
- time (Coordinated Universal Time [UTC])

- time of high tide (UTC)
- profiling equipment (i.e., brand, model, and serial number)
  - equipment calibration bar check results
  - unusual conditions
  - brief description of the area around the survey line location and the weather conditions at the time of profiling
  - description of transect beginning and end points

5. References

Tierra Solutions, Inc. 2012. Quality Assurance Project Plan for Newark Bay Study Area: Multi-beam and Single-beam Bathymetric Survey. Revision 1. December.

U.S. Army Corps of Engineers. 2002. Engineering and Design – Hydrographic Surveying. EM 1110-2-1003 Modified April 2004. Available online: http://publications.usace.army.mil/publications/eng-manuals/EM_1110-2-1003_pfl/toc.htm.

U.S. Army Corps of Engineers. 2002. Engineering and Design – Hydrographic Surveying. EM 1110-2-1003 Modified April 2004. Available online: http://publications.usace.army.mil/publications/eng-manuals/EM_1110-2-1003_pfl/toc.htm.

The standardized procedures detailed in this manual have been adopted for the bathymetry surveying in the NBSA for multi-beam and single-beam survey methods. The manual is available online at the website provided above. The following page shows the website and contents of the manual.

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